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The
GEOGRAPHICAL JOURNAL

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A JOURNEY TO THE GLACIERS OF THE EASTERN KARAKORAM: *A paper read at the Evening Meeting of the Society on 11 January 1932, by*

PROFESSOR GIOTTO DAINELLI, Accademico d'Italia

IT may perhaps seem superfluous that I should say why I undertook this journey into Eastern Karakoram. But for its story's sake I may mention that I had the great fortune of being a member, as Geographer and Naturalist, of the memorable expedition organized by Dr. Filippo De Filippi and led by himself in 1913–14. During that time I asked and obtained from the leader the widest freedom of action and movement. And thus for a whole year and a half, nearly always alone with my very light personal caravan, I was in continual movement, because I knew it was necessary, for my own experience of the region and for the contribution I could bring to its knowledge, that I should see as many valleys and glaciers, as many plateaux and villages or shepherds' camping grounds as I possibly could. And thus at the end of the expedition I could say to myself I knew all Baltistan and all Ladakh and the first Tibetan plateaux as far as Pankong lake and the Aksai Chin.

One blank, however, had remained: the Nubra valley from its mouth in the Shyok valley to its origin in the Siachen glacier. The Nubra valley in its lower half is frequented by caravans which cross the Karakoram Pass during the summer, and it has been followed by various travellers; however not much was known about it, and I had special ideas regarding its population, from an anthropological point of view. The upper half of the valley had been climbed by very few travellers indeed. Of the old ones, Moorecraft in 1821, Vigne in 1835, Thomson and Henry Strachey in 1848, and some years later by Drew. Then we come to quite modern times, with Longstaff in 1909 and the Vissers in 1929; but its geological conditions were practically unknown.

At the head of the Nubra valley is the Siachen glacier, which is said to be the largest glacier on Earth outside Polar regions. Longstaff had discovered and been on it in 1909, the Workmans followed in 1911 and 1912, and also the Vissers climbed it in 1929, but only for a few miles from the front upwards. Of the geological conditions of its immense basin nothing was known. And this represented the chief blank in my personal knowledge and in connection with the attempt that I have been preparing for years, of reconstructing the

geological history of the entire region, which is the last part, and perhaps not the least important, of the scientific results of the De Filippi Expedition.

This blank represented a wish on which for years I dwelt with always greater affection. To this you can add the longing I felt for the free caravan life, and that peculiar longing for a region which is grand in its landscape and highly interesting in its inhabitants. All these reasons of attraction grow all the greater when you think of the life a man of study leads in his own town, tied down to his writing table and by his numerous duties.

At the end of 1929 I could resist no longer, and decided for the Nubra valley and the Siachen glacier. And I worked out my own programme. As my programme was merely the manifestation of my personal wish to fill up a scientific blank—a blank not only mine—and to live again the healthy strong and free life of travel in regions neither well known nor of easy access, I wished my expedition to represent only a personal initiative of my own: I did not ask nor seek the help of any society nor of any committee. But this fact, though it brings as a consequence no light financial weight for a poor professor, as in no country in the world are professors wont to swim in gold, also brings the immense advantage of the most complete freedom and independence. Thus it was not necessary for me even to announce my programme. I chose my companions and set to work at my preparations.

My companions were to be very few. Miss Elly Kalau, my faithful collaborator for some years, a strong alpinist and skier, and prepared for the journey, if only by tradition in her family which has produced naturalists and travellers. Doctor Ardito Desio, my former pupil, possessed of a wide scientific preparation and quite good experience as a traveller; unfortunately he was hindered at the last moment to join me on account of his University duties. Third in my programme was Hashmatullah Khan, an Indian whom I had known as Wazir in Ladakh, and who had helped me a lot in my researches, rendering them easy in every way with the authority due to his official position. I meant to do without interpreters or caravan leaders, feeling capable of managing the men by myself, even in case of eventual difficulties.

The greatest difficulty I experienced perhaps during the period following my decision, namely in obtaining the necessary permits. From Rome to London, from London to Delhi, from Delhi to Srinagar, and then all the way back: that way is a long one indeed. And only in February did I finally receive the news that I was lacking no further official sanction. I like to name this date, especially when speaking to Englishmen, who are men of action, and who can therefore measure the rapidity with which my journey was organized. In one month, exactly, everything was ready, and on April 9 I left my own town, Florence, foretasting the delight and the enjoyment that were in store for me. However the rapidity was not to last only during the time of preparation: it had to be kept up also during the first part of our journey, that is during our movements of approach towards our still far-off goal—the Siachen.

The summer campaign, in fact, is perforce very short, and sharply limited within the year, when the essential part of the programme is to evolve on high glaciers; and in this particular case the upper Nubra valley was so renowned for its not easy accessibility, owing to the summer floods of the river, that any delay would have meant a serious menace to my entire programme.

At Bombay two days' halt to verify the food supplies, ordered from Italy at the Army and Navy Stores; then straight to Kashmir with the whole luggage of my expedition; five days at Srinagar to arrange all the loads and organize the crossing of the Zogi La, which did not present itself favourably, on account of much snow and numerous avalanches. And in fact it proved not an easy matter, but on May 9, just one month after leaving Florence, I was in the small bungalow of Machhoi, beyond the pass across the Himalayas, with all my 180 loads.

For some days still, on account of avalanches and landslips, the way was not always easy; then up the Indus valley our marches became faster until we reached Leh. On the way however I deviated towards Temesgam, to engage forty permanent porters in that village and in the neighbouring one of Teah, as I had never forgotten the solid qualities of the men who had followed me during the summer campaign in 1914, in the fatiguing and uncomfortable marches to the glaciers of the upper Shyok valley and on the first Tibetan plateaux, giving proof of a strength of resistance and faithfulness beyond comparison.

At Leh five days' halt, but not of rest indeed. The passes of the mountain range towards the Shyok valley were all under snow, and the most direct one, the Khardung La, was unpassable. From the first day I started sending ahead the main bulk of loads by small separate caravans, across both the Digar La and the Chang La. In the bazaar I bought part of the food supplies for the porters, that is butter, tea, salt, also tobacco, enough to last four months; and I sent at once into the Nubra valley a trustworthy man to buy and collect on his way as much flour as he could possibly obtain, according to the custom of the country, of barley and wheat.

On the fifth day I also started together with my caravan, crossing the Digar La in a somewhat tiring eleven hours' march, and reached Panamik in the Nubra valley after some days, having picked up on the way all the flour that my man had been able to gather all along the valley. As I at once pushed on beyond Panamik, the Nubra river did not present any difficulties, and I reached the front of the Siachen glacier, with my 180 loads which I had taken with me from Italy and then from Bombay, plus 7 tons of food for the porters and, if you are interested in the lesser details, with a small flock of sheep, 120 living chickens, and a provision of 120 dozen eggs. I remember how in Florence, just a few days before my departure, Dr. Longstaff recommended to me above all "food, food." You must admit that I had done everything to put into practice his excellent advice. And on June 9, exactly two months after my departure from Florence, I personally led a caravan to form a first depot some miles up on the glacier. You will acknowledge that a greater rapidity could hardly have been possible.

Now began our march up the glacier, and began for me the greater difficulties, namely those imposed by logical necessities. In a completely uninhabited region it is absolutely ridiculous to think of augmenting the number of men so as to diminish the difficulties of transport, because men have the unpleasant habit of eating, and therefore require provisions for their necessary feeding. Just think that a porter normally carries, in uninhabited regions, a useful weight of about 48 lb., and eats daily something more than 2 lb. He

carries thus about twenty-four days' food for himself, whilst my programme had planned a stay of nearly four months in uninhabited regions. Hence the necessity of recurring to expedients which constitute surely the most difficult thing in a journey like mine. The secret is to reduce the number of the men as much as possible, and to encourage them to the limit of their capacities and of their strength. My men made double stages every day, during three and a half months; but only thus, with that constant effort required of them, have I been able to overcome the really very great difficulties I met with. A caravan of seventy porters accompanied me to the centre of the Siachen, during our first fifteen days on the glacier; fourteen were then sent back to their villages so as to lessen the number of mouths to be fed.

The advance had not been a difficult one. I can certainly deny without hesitation the fame of inaccessibility of the Siachen's front, which, besides, had already been climbed by Longstaff and by the Vissers, though only for some miles. The extreme snout, as in nearly all large Karakoram glaciers, is broken up into a gigantic intricacy of ice hillocks, more or less covered by moraine, and furrowed by deep little valleys and often cut up by perpendicular walls. But with some patience and numerous windings the way is to be found. Farther up the glacier's surface changes its aspect, longitudinal zones or bands appear, some of them consisting of pure ice, others instead of moraine. The pure ice usually rises above the general surface to form tall banks or high series of picturesque pinnacles, and also the moraines form complicated broken and irregular ridges. Inconvenient, sometimes difficult, is the crossing of the glacier, consisting as it does in overcoming these obstacles. But to climb up it is easier, because you can always find a longitudinal zone between some embankment of ice and some moraine ridge, where marching is relatively easy and fast.

More difficult perhaps is the establishing of the camps, because you must avoid depressions which are always so inviting but dangerous in case, for instance, of a sudden emptying of one of those numberless lakes which dot the surface of the glacier; neither is it easy to find sufficient space to put up the tents, and it is mostly necessary to level moraine and ice, trying to avoid the too dangerous vicinity of crevasses. But all my camps on the glacier have left in me the remembrance of something supremely and inexpressibly picturesque.

Farther up the Siachen's surface tends to become more uniform, banks of ice and moraine ridges smooth themselves down; our vision of the neighbouring slopes and of the mountains in the distance grows always wider and grander and marching becomes easier and faster. When I arrived not far from the junction with the Teram Shehr, the principal affluent descending from the east, I deviated and abandoned the main tongue of the glacier, and reaching its rocky border I established a camp at about the same place where the Workmans had stopped already eighteen years before. This became my base camp for more than one month and a half.

My base camp halfway up the Siachen was simply wonderful. Imagine its position at about 20 miles' distance up from the front of the glacier, which extended itself for another 20 miles to its head; on one side, towards the east, the Teram Shehr came flowing in, measuring by itself alone about 18 miles,

Third camp on the Siachen Glacier; mountains of the right flank in background

Base camp beside a lateral lake on the left side of the Siachen and near the confluence of the Teram Shehr Glaciers

and from the opposite side came the Lolofond glacier, less long, but having other glaciers beyond its head before reaching the depths of some ice-free valley, just as beyond the Teram Shehr stretches the immense tongue of the Rimo. It is difficult to imagine an ice world of such immensity. Nevertheless there in the middle of it my base camp was like an oasis, well sheltered from the wind, well exposed to the sun rays, on the margin of a small lake shut in between ice and rocks, and surrounded by a vegetation and a flora which in all the Karakoram Range, even outside the glacier region, is really unusual. Rarely have I seen in our Alps high pasture grounds with such an intense abundance of flowers, of every kind, of every colour, and of every perfume. There was also a rich and varied fauna in which the hibex reigned supreme, that came down to graze every morning in groups of dozens and dozens and gazed stupefied at this strange invasion of men and tents and at the movement and activity that seemed to agitate this corner of their ice world. As a culmination to our good fortune we also found a great quantity of burtse, that little plant the small boughs of which make good fuel. It thus became unnecessary to refurnish our camp with juniper wood, which is relatively abundant near the front of the glacier.

Everything was of interest around my base camp, also the lake. After my arrival its level began to rise, at first rapidly, then more slowly; but after having risen over 70 feet it ended by endangering my camp, and I was obliged to set my tents higher up on the slope with all the boxes and bags that had accumulated around them. Then however the lake began to decrease, at first slowly, then with always greater rapidity, and on the last day of my stay in the oasis it emptied itself almost suddenly, whilst the Siachen's ice masses, robbed of their support, split up into large crashing blocks. My porters said that as the bara-sahib—the great lord, by which name they meant me—was leaving, so also the spirit of the lake was going.

The base camp naturally was not an oasis of rest. It was the centre of excursions upward along the Siachen and along its main affluents. These excursions were also difficult to organize: there were still loads to be fetched from the front of the glacier; fourteen men, as I have said, had been sent back; permanently five or six were on the sick list; and moreover I had not come to the Siachen from Florence to idle about amongst the flowers near the lake of my base camp. The solution I found to the difficulties was to organize a system of flying caravans, generally led by Miss Kalau, which were to make depots of food and fuel in places easy to locate. These caravans accomplished as many as three stages and more a day, and made it possible for the following caravans to move with very few men and more slowly according to working exigencies. I am glad to think that not one man during the whole time that my expedition lasted was kept in want nor short of food or fuel.

In the meanwhile the Siachen revealed itself always more to my curiosity as a naturalist and to our admiration as alpinist travellers. Above the base camp, where the glacier presents its greatest width, of over 3½ miles, it grows steadily more uniform, the moraine ridges do not only become depressed, but they also separate from one another, and individualize always better; and each one can be traced to its origin, in one or the other of the mountain spurs at the foot of those ranges. Still farther up they disappear completely beneath the even

mantle of the eternal snow, which levels everything and also hides insidious deep crevasses.

One must not believe however that the glacier's uniformity is as great as it appears when seen, from above and at some distance, from the rocks overhanging my base camp. Though high ice-banks and elevated moraine crests are not found here any more, yet there are tracts all broken up into pinnacles and pyramids and spires, where the hollows are invaded by numberless lakes, which are sometimes rather difficult to cross; also real watercourses on the ice, rivers, and torrents can be met here, with deeply excavated beds, running often between almost perpendicular banks, where patience is needed to find some way across, often only on a feeble snow bridge, which in its turn requires prudence and the use of the rope. But these are not real difficulties for those who are experienced alpinists, and for men like the Ladakhs who follow faithfully where their master has passed before them.

But the spectacle of that immense glacier world and of those fantastic mountain circles was supremely wonderful. The mountains above all perhaps, for although disposed in series constituting ranges and watershed ridges they seem to show, each one of them, an individuality of its own, as if some artificer had modelled them thus, with mighty blows, out of the compact mass of rock. And each one seemed to have its special physiognomy, be it the long crest of the Teram Kangri, or the pyramidal and most daring peak of the Rose, or the Twins joined in their massive power, or the Ghent, with its snowy summit divided like a saddle bow, or the Hawk, its upper part resembling the beak of a bird of prey, or the Hardinge and the Queen Mary, in the King George Group, with their daring pointed peaks, or the Hidden Peak, a gigantic block and the extreme bastion between Siachen and Baltoro glaciers. Of these names I think that only Teram Kangri is officially admitted.

Two months had thus passed on the glacier. I had to think of our departure. In fact I had been thinking about it for some time already, with all the more preoccupation as the news in the meanwhile had not been of the kind to leave the leader of an expedition quite indifferent. A weekly service of couriers had been established to descend into the Nubra valley with my post and bring up that which might have come for me from below and from Europe. For two weeks everything went well. But already the first couriers I had sent from the base camp had found the Nubra so swollen and impetuous, on account of the beginning summer floods, that they were unable to ford it. I thus remained completely blocked on the glacier, completely shut off from the outer world. The consequences, as you can imagine, were not of the most agreeable: impossibility to receive those last food supplies for which I had arranged, and impossibility to send back some twenty porters, as I had planned, so as to facilitate my exit from the Siachen, which was still full of uncertainties.

My plans in fact had foreseen to leave the Siachen with not more than forty men; I found myself with seventeen more with a long journey in front of me, with food supplies that were forcibly becoming scarce, and with a new way ahead, already attempted without success by the Workmans, who had failed because of the difficulties they encountered, failed though they were not followed by a loaded caravan, but alone with two famous Alpine guides.

You must remember that Dr. Longstaff in 1909, and the Workmans in 1911

Peaks 35 and 36 from the east

Mount Lakshmi on the left of the Teram Shehr Glacier, flowing from the left

and 1912, had entered the Siachen and had also left it by the Bilafond La, a pass to the west leading into the Saltoro valley in Baltistan. My plan had been, instead, to leave towards the east, by that unknown pass, which presumably led to the Rimo glacier, explored by the De Filippi Expedition. The Bilafond La was the known way, which would have brought me in a few stages into inhabited regions; by the unknown pass I would have to descend the whole Rimo and part of the upper Yarkand valley, reaching the Karakoram caravan route, and then follow it for twelve good stages, before reaching the first villages.

This way, I repeat, had been attempted up to the col by a caravan consisting only of alpinists and two Alpine guides. And the attempt had failed. Some one may think perhaps that I was rather too daring in wanting to follow it with all the loaded caravan and in the particular conditions in which the Nubra had unfortunately placed me.

I decided to anticipate the departure by five days, as this would procure me a corresponding economy of food supplies. I told my men that during the crossing of the glaciers I would continue to distribute complete rations, reserving to myself the right to shorten them once outside the glaciers, if it should prove necessary. They agreed to whatever restrictions I might decide upon, for they knew it was a question of *force majeure* independent of my will and my preparations.

And thus in the first days of August I began to send food and fuel up the Teram Shehr glacier, which was now to be my way of exit. Just think that of burtse alone there was more than a ton. On the 7th I folded up the tents of my base camp, where an inscription on a moraine block marks the dates of my stay there, and I began to ascend the Teram Shehr, which for two good stages is nearly as easy as a highway. And thus far the Workmans had pushed forward with their two guides, and thence had tried to reach the col.

Let us see what they have written of their attempt.

"Seen from the Rose [or Siachen] this glacier [the Teram Shehr] appears to rise gradually for miles, but in reality its higher part was composed of three slopes broken by short snow-terraces, and its whole upper area was cleft by crevasses of a size and depth not met with on the Rose or its other large affluents. A wide plateau was finally reached lying at over 18,000 feet. This white sea is cut up by shrunds and chasms running in all directions. Leading the caravan cautiously in and out of this maze, we advanced slowly, until Savoye said the responsibility for him was too great, as the caravan might at any moment become engulfed in this vortex of seemingly bottomless chasms. We had wished to reach the end of the plateau, now quite visible, and see if any possible passage existed leading towards Nubra and the Remo glaciers, but this was no smooth lustrous expanse, such as are some elevated plateaux in Himalaya, but a mountain devil's snow-continent set with death traps to entice unwary men into their pitiless jaws."

There was reason to be at least somewhat preoccupied. I won't hide that in fact I did feel a bit so, especially on account of my caravan's weight, that is for the great number of loads which obliged me in the beginning to repeat three times every stage, then twice only, as soon as the consumption of food had rendered it possible.

But the leader's troubles were not yet over. No sooner had we reached the Teram Shehr than it began to snow. And then persistent adversity of

the weather set in, with nearly continual snow, thick fog, and violent windstorms. As soon as the fog lifted even slightly I had to fix well in my mind the topography of the glacier, so that our going should consequently be as little dangerous as possible. Many times was I forced to stop on the way because the storm prevented my proceeding any farther. But, since fortune helps the audacious, as our Latin forefathers said, I succeeded in avoiding the worst crevasse fields, and with continual prudence and giving personal aid to each porter whenever it seemed necessary, for the glacier was treacherous, I overcame the worst difficulties, in spite of the weather's obstinate adversity. And when on the eighth day of this period of trial the fog finally cleared, the clouds vanished, and the sun reappeared in a radiantly serene sky, my tents were set up against the rocks in the now immediate neighbourhood of the pass.

From here, in a few hours' time, the col was easily reached, the large tongue of the Central Rimo descended from it, which I recognized in every detail of its own and of its surrounding mountains. A long descent on skis brought me halfway down its length, against the left rocky border, in a miserable camping ground, where I was forced to remain for two days, so as to collect all the loads that had been left behind.

The descent along the Rimo was almost playwork, almost like taking a walk. Not so our exit from it. I meant to leave it by that northern tongue which during the De Filippi Expedition both Major Wood and I, each one separately and at only two days' distance, had discovered to be the source of the Yarkand river. But the front of that glacier was so much swollen, and ended in an ice-wall of such height, that it was impossible to find a way out on the evening of our arrival. I was forced to pitch our tents there, on the extreme edge of the glacier front, and it seemed as if the Yarkand river were mocking me all the time, running so quietly just below me. We even got into our sleeping-sacks without a warm supper that night, because our fuel supply had just then come to an end, so precise had been my calculations for the necessary economy of loads.

One whole day was needed to get out of the Rimo. You will understand my emotion when, setting up my tents under the shelter of some rocks, I discovered a heap of dried-up burtse, abandoned by myself sixteen years before when I had been camping in that same place.

Thus the expedition could be considered as come to an end. Not yet however my various preoccupations. I immediately reduced the food rations of my men and speedily started on the return march. But luckily, near the Karakoram Pass, I met a relief caravan, on which I had not really counted much, as from the Siachen I had been unable to send any precise orders. But the general arrangements I had made in the Nubra valley had been so marvellously carried out that I was now again swimming in plenty, just at the moment when restrictions had been imposed by circumstances.

By the Karakoram caravan route I returned into the Nubra valley, by the Khardung La to Leh; by the high passes of the Rupshu into India at Sultanpur. Thus the journey was ended.

I regret that the limit of time has hindered my saying more about the majestic grandeur of the Siachen and its mountains, and my showing you a

larger number of those photographs which Miss Kalau's intelligent activity has contrived to bring back. It is certainly not sufficient to be accustomed to the beauty of the high mountains in the Alps to form an adequate idea of what are the mountains and glaciers of the Karakoram. The scale is so different, so uncommonly grand, that those phenomena and those shapes which are quite familiar to us in the Alps seem almost new. The surface rivulets, which can be crossed by one step or by one jump on our glaciers, there, in the Karakoram, are or can become great rivers, broad and deep and impetuous; the small pools of our Alpine glaciers become large lakes on the Karakoram glaciers, and can be found innumerable among the moraine hills or in the lowlying portions of the crystal ice. The small irregularities of the surface, which in the Alps seem and are small details, almost miniature shapes, there become gigantic banks, forests of pyramids, labyrinths of spires, amidst which, if the sky is uniformly covered, it is necessary to use the compass, so as not to lose our direction. The glaciers are so large that it is difficult to embrace them at one glance, while they flow along, though scarcely winding, in their gigantic troughs; and the mountains are so high and full of majesty that any one of them having there the importance merely of a small detail of a secondary range has in itself the majesty and grandeur of a Mont Blanc seen from Courmayeur.

All this is more than sufficient to fire the imagination and to satisfy the passion of one who feels deeply all the fascination of the high mountains and knows, from a now long experience, that nothing like the high mountains can give full satisfaction to every sense of beauty and a serene and absolute calm of the mind to him who has known how to conquer them.

But allow me to say when the traveller is also a geographer, also a naturalist, his satisfaction must be, and is, far greater, even if the world, more or less, would go on just the same even without knowing what rocks constitute the Siachen basin or what flowers adorn that rocky corner, that seems a small paradise made purposely to receive the traveller who should venture into that glacier world.

I can say that I have experienced all these special satisfactions. And I allow myself to set them before you briefly in this place and to an audience amongst which are men who have accomplished memorable journeys in the Karakoram Range. It is enough to mention Lord Conway, Sir Francis Younghusband, and Dr. Longstaff, to whom we owe the first and real discovery of the Siachen.

There was the small topographical problem concerning the col between Siachen and Rimo. The Workman Expedition in 1912, as I have already said, had attempted but had failed to reach it. From the travellers' accounts it seemed that they believed they had seen it. But it was simply an illusion, since from the place they had reached the col is not visible.

The De Filippi Expedition, in 1914, did not even try to reach it from the Rimo glacier: they stopped at a distance of several miles from it, but, as it is a typical tableland col, they were able to sight it though only indistinctly, as was then my impression, and as I have ascertained later.

Further, the map of the De Filippi Expedition sets down, though incompletely, that which ought to be the southern side of the Karakoram watershed range in correspondence with the Central Rimo's summit. Major Mason, from the Shaksgam valley, surveyed the northern side. But between one and

the other there remained a blank space, which the recent edition of the Map of India has logically filled up, imagining a long and narrow glacier as an affluent of Northern Rimo. This representation did not convince me, so far as I remembered the Rimo.

These were all good reasons, though simply topographical ones, that added themselves to the others to induce me to include in my programme the crossing of that col, and to make me persist in that programme in spite of every difficulty and of the contrary weather. Results proved that I did well in persisting.

The col, which is about 20,000 feet in height, is situated about 3½ miles more to the east than the place shown on the recent maps. It is not closed in, as the maps show it, between two opposite mountain spurs, but is wide and placed on a kind of plateau, where from both opposite directions, from the north and from the south, two large glacier branches of alimentation come flowing in. Besides, of these two branches, the southern one, which, according to De Filippi's map would aliment the Rimo, in reality is alimenting the Siachen, and its head is not shut in, as the map has it, by a mountain ridge, but ends in an ample level saddle, by which it must be possible to reach the more southern glacier explored by the Vissers in 1929.

That long and narrow glacier placed in the maps immediately south of the principal watershed ridge as an affluent of Northern Rimo does not exist; into the northern Rimo runs, correspondingly, an insignificant small valley and not a tongue of ice 8 miles long. And the Central Rimo actually reaches with its head the principal watershed ridge of the Karakoram. Thus the large collecting basin of Central Rimo is determined, a collecting basin however not simple and uniform as it would appear from the maps if that inexistent ridge were taken away, which limits that imaginary glacier to the south, but a basin, rather than divided up by real mountain ridges of some length, interrupted by isolated hillocks, especially in its more southern portion.

This upper basin opens out widely from the north on to the col which I crossed; it opens on to the col like a gigantic fan of ice, alimenting simultaneously both the Siachen and the Central Rimo.

One more remark. The recent maps give, immediately east of the col, a narrow and rather long glacier, shut in by two mountain ridges, which is supposed to feed the Rimo. As the col is really situated much more eastward, that small narrow glacier would feed the Siachen. But in reality it does not exist. To understand how it comes to figure on the Indian map we must think how this map has necessarily been constructed for that region, that is by joining both Workman's and De Filippi's maps, according to the geographic co-ordinates. But one of these two maps must contain some error in the geographic co-ordinates, because those two mountain ridges, which there appear different and separate, leaving a gap which the Indian map has been obliged to fill up by placing between them a small narrow and long glacier, correspond in reality to the same and only ridge seen from the two opposite directions. That there must be some error in the geographic co-ordinates, in one or the other of the two maps, can also be proved by the fact that a peak, figuring on both maps with an identical quota, does not coincide as to its position, but appears in two distinctly different places, and therefore is doubled, in the same way as the ridge was doubled, which in reality is only one.

Zone of the Colle Italia from the north; the pass is just to the right of the crevasses in the middle of the photograph

Zone of the Colle Italia from the east; in the middle the huts of Professor Dainelli's first camp on the Central Rimo and his caravan tracks down the glacier are visible

These are the essential modifications to be introduced in the recent maps of the region: not very great ones, naturally, as they certainly do not revolutionize the Karakoram topography, but yet they may have a certain importance, seeing that to reach the col between Siachen and Rimo is not as simple as taking a walk between one meal and another.

Let me record a few more among the results of my expedition. When I was in that region the time before, I intensified my excursions so as to obtain also elements for the sketching of a geological map, that should be at least an improved and more up-to-date edition of Lydekker's old map of about fifty years ago. There had remained for me the blank of the Siachen's basin; and now, at least partly, this blank is filled up since I know which part in the geological constitution belongs to intrusions of granite, which to antique crystalline rocks, which to the Permian period of normal facies, and also which to the Trias period of Dolomitic facies.

The time before, from a very vast region, but of which no fossils were known except through vague, uncertain, and even erroneous indications, I was fortunate enough to bring back large collections almost of every geological epoch, from the Silurian to the Eocene. But also this time, even though less abundantly, I brought back fossils both from levels from which I had already collected, and from levels that I consider new, belonging to the Permian, to the Trias, and to the Jura periods.

As to the morphological problems connected with the phenomena of the Quaternary period, I could not hope to bring back anything very new. I have already published a study of a monographic and extensive character on the Quaternary period in the whole of that region, and, by analogy and by induction, I have already said what must have been the conditions of the Nubra valley and of that short tract of the Shyok valley which I yet did not know. I have the satisfaction to state that what I have now observed confirms, I can even say completely, all I had previously inferred.

At the base camp, in the centre of the Siachen, at 15,000 feet above sea-level, during a month and a half, registering instruments recorded the temperature, the dampness, and pressure. They will bring a contribution to the knowledge of the daily course of these meteorological elements.

Thanks to Miss Kalau, a diligent gatherer, I have brought back several hundred specimens of high mountain plants. As before, I again did not consider it necessary, with the many occupations I had, to think of the flora in the lower valleys, where so much has already been collected and where I, simply passing through, could have gathered but little. But again, I did not want to neglect the flora of the real high mountain areas, where very few travellers have collected and where it is possible to be thorough, or nearly so. My botanical colleague to whom I entrusted the Alpine flora brought by my expedition assures me it is the richest that has yet come from the Karakoram region; especially interesting is that of my base camp's glacial oasis.

The time before it had been my task to draw the plans of the different houses, so that I believe this essential element of the material human life is now well known in reference to the region from Baltistan to the first Tibetan tablelands. I was still ignorant as to the Nubra valley; but from the Nubra valley I have now brought with me plans of houses sufficient to show the

similarity of the general structure and the local variations due to the influence of the milieu.

The time before I brought back the anthropometrical measurements of 450 individuals, taken in a way that for each people one had a series sufficiently long to allow the anthropologist to make his deductions, as in fact he has done. This time I have measured another 150 individuals, divided in three series, namely three groups of different peoples.

And finally I may mention a small discovery, which can interest those who know the Karakoram. In one of my studies I have endeavoured, some time ago, to reconstruct all the routes followed in former times by the Baltistan natives across the large mountain range. Also the Workmans had affirmed that the Siachen itself was normally visited by the natives, but evidently what they had heard was a purely fantastic legend, namely that a real town had existed on the rocks halfway up the glacier. From sure accounts I collected in the Saltoro valley and from evident traces of a shelter arranged by human hands, right at the northern front of the Rimo, I had concluded that the Baltis used, as a way towards Yarkand, also that one which, starting from the Saltoro valley, climbed the Bilafond La, crossed the Siachen, ascended the Teram Shehr, surmounted the pass between Siachen and Rimo, and finally, descending this last one, ended in the Yarkand valley. Well, ladies and gentlemen, when, having established my camp under that pass, the fog cleared and I was able to make a proper inspection of all the neighbourhood, I discovered above the rocks near my tents two cairns of perfect shape, as if they had only just been erected. Thus my hypothesis that this way had been used by the natives in former times was completely proved.

Some one might philosophize on the illusion we live in, we who believe we are exploring and discovering that which other men, instead, have known before us, perhaps for centuries. But we explore and discover for the sake of general knowledge and of science, and we cannot feel diminished if only in this sense be understood the discovery of the Yarkand source from the Rimo, made sixteen years ago, or the so-called first crossing of the col between Rimo and Siachen. For geography and for science, as well as for alpinism, it has certainly been the first crossing and therefore, in remembrance of the contribution which my fellow citizens have brought to the knowledge of the Karakoram, I have allowed myself to give the name *Colle Italia* to this pass, crossed for the first time by a caravan led by a European.

DISCUSSION

Before the paper the PRESIDENT (Admiral Sir WILLIAM GOODENOUGH) said: No session passes without at least one evening being devoted to a consideration of some part of the Himalaya, and we may say that the Karakoram is part of the Himalaya. I speak with certainty on that, for having no experience of those parts myself I consulted what I considered to be expert opinion. Of that great range of mountains which would seem to be the backbone which supports half Asia, buttressed and branched and ribbed and jointed for hundreds of miles, the more we hear the more we want to hear. To-night we are to hear of a portion of the Eastern Karakoram from one who combines in a very remarkable degree the geographer, the traveller, and the mountaineer. Professor Dainelli is a member

of the Academy of Italy, and that in itself is a great distinction. He was educated at the University of Florence. In 1914 he was given the Chair of Geography at the University of Pisa. From Pisa he went to Naples, and has now returned to the University of his native town, Florence. His journeys in Eritrea with Marinelli resulted in more than one volume on the geography and geology of those regions, and these have become standard text-books. In 1913–14 he was in Asia with our very old friend Dr. Filippo De Filippi, and has written several of the volumes on the geography and the kindred sciences of those regions resulting from that expedition. In 1930 he undertook the expedition of which he will give us an account to-night.

Professor Dainelli then read the paper printed above, and a discussion followed.

The PRESIDENT: We find ourselves to-night very fortunate. Not only have we had a most charming and interesting lecture, but there are three men whom I am going to ask to speak, all Gold Medallists of this Society. The first has been absent from our platform far too long. Now that he has been, shall I say, moved from one legislative assembly to another I hope that he will find time to come and speak to us a great deal more. I will take this opportunity of offering him, on behalf of the Royal Geographical Society, our very sincere congratulations on the honour which has been bestowed upon him by His Majesty.

Lord CONWAY: Our lecturer has said that when he went amongst the mountains of the Eastern Karakoram, of which he has spoken to us to-night, he had the illusion of being fifty years younger than he really was. I can assure you that there is a much greater defect than that that makes me feel exactly fifty years older. I am sure we have all been delighted by the lecture to which we have listened. To me, and perhaps to most of us, the greatest charm was not its importance as a piece of geographical exploration, but as a revelation of beauty. I do not think it often happens, beautiful as are the visions that are thrown upon this screen from time to time, that we have shown to us in one evening a series of not merely beautiful slides, but slides taken of beautiful scenery from the best point of view, one after another. We were so enraptured that sometimes perhaps we failed to realize all the difficulties of the journey.

My own travels in the Karakoram happened so long ago, are so far away, that though they are not forgotten by me they might have ceased to be really vivid memories. But, as a matter of fact, it is a quality of the Karakoram Mountains to a very peculiar degree, when I think of them as compared with other mountains of the world, to fix themselves in detail with extraordinary firmness in the mind, so that they become possessions for the whole of the rest of one's days. The part of that great mountain region that I visited is to the west of the part we have seen to-night, and it consequently happens that the exploration of those mountains that I have been able to read about and to follow in the pictures has just missed the junction between where I went and where the travellers who visit the Siachen and that district generally go. I noted that the long glacier about which we heard to-night stretches up somewhat west of north and appears to draw its original ice-flow from the back of that great mountain, Gasherbrum. I only saw the western side of Gasherbrum and its neighbouring peak, which appears to be part of the same mountain mass, called the Hidden Peak. Gasherbrum is one of the finest mountains in Asia, but I always wondered what it would be like on the other side and whether there was a way over the saddles that seemed to beckon one to try to cross it. I believe that there is a possible way across from the Baltoro glacier eastwards over what I called the Probable Saddle, and, if there is, then it would be one of the very finest passes in the world for any explorer to discover.

Personally, I do not believe peak climbing is worth very much in the Himalaya.

It is a great feat to have accomplished, but for enjoyment and pleasure give me the Himalayan passes, those great passes with their wonderful views, with their great upper snowfields, so large, so wide, so white, and so placid, and beyond them, rising towards the horizon, white peaks of no great relative elevation in themselves but almost like Arctic peaks. There, on the upper levels, you find such beauty and such loveliness in light, shade, form, and colour that you win a greater reward, I feel sure, in investigating and following passes than any peak in the Himalayas can give you. The great peaks, we hope, will be explored. Kangchenjunga is hopeless, but there is Nanga Parbat and there are other great mountains which it would be a memorable feat to accomplish and I think may be accomplished; but if I were to have my life to live over again it is not peaks but passes which I should choose.

Well, we have listened to our lecturer with great interest and delight, and we thank him most cordially for having come amongst us. We can assure him that he will have left behind him in the minds of those who have listened to him this evening memories of a most delightful kind which will last as long as we can think.

The PRESIDENT: If, when you go out, you will look on the board at the other end of the corridor you will see a map of the region of which we have heard to-night. That map, which I believe I am right in calling a sketch-map, was made in the year 1889 by Sir Francis Younghusband.

Sir FRANCIS YOUNGHUSBAND: I have listened with extraordinary interest to the lecture by Professor Dainelli because, quite unconsciously, he discovered the pass that I had been looking for forty-two years ago—that pass which he has very appropriately called the Colle Italia. In the year 1889 I was sent by the Government of India to examine all the passes that might lie across that range between the Karakoram Pass and the Pamirs. In the year 1888 a Russian traveller, Captain Grombchevsky, had crossed the watershed into the little state of Hunza. Now news had come to the Government of India that he was about to start from St. Petersburg to come again into that region. So at the beginning of July 1889 I was commissioned by the Government of India to proceed as rapidly as I could to the Karakoram Pass, thence to the Shaksgam river, which I had discovered in 1887, and then find my way into Hunza. The main idea was to discover the passes into Hunza. But we also had heard of a mysterious pass which some called the Saltoro pass, which led into Baltistan, and it was that pass that, if I had time, I was asked to try to find. It might be such a pass that small parties of Russians could use to penetrate into Indian territory.

I went down the Yarkand river, and over into the Shaksgam valley. All this country was very badly and erroneously marked on the maps in those old days. The Siachen glacier was not known until Dr. Longstaff discovered it many years afterwards, and I tried a pass which I thought was the Saltoro pass and found it quite impassable for anything in the way of a military party, however small. And there the matter rested for many years, until one day in London I heard of a British officer who had been shooting in Chinese Turkistan. His leave was very nearly up, and instead of coming back from Turkistan by the well-known route of the Karakoram pass his shikari said that he knew a short way into Baltistan and would take him by it. The shikari took him by the short route, and I happened to meet the officer one day in Piccadilly and asked him by what pass he had returned to India. He had not the least idea. All he knew was that it was not the Karakoram pass and that it was not the Muztagh pass which I had crossed in 1887. It was somewhere in between, and it had brought him into Baltistan, but where it was he had not the faintest idea. There the matter rested. I am sorry to say I have forgotten the officer's name, though I believe it was Knox Niven.

Now we know that there is a pass, the Colle Italia, which does lead from Turkistan into Baltistan, though whether that is the one that the British officer crossed I do not know. At any rate, to-night we have had the mystery of forty years ago cleared up. Also we have seen most beautiful photographs of that pass and the wonderful region in which it lies. And I can join with Lord Conway in thanking Professor Dainelli for having brought back to us some of the beauty of that marvellous region.

One word in conclusion. The Italians seem to have annexed that part of the Himalaya for their explorations, and as an ex-Resident in Kashmir I should like to testify not only to the value of the work that they do there, but to the good name which they have established in those regions. Anybody who has been in the position of Resident in Kashmir knows that travellers can be divided into two classes: good travellers and bad travellers. The bad travellers are those who get themselves horribly disliked by the people of the country and give the officials an infinity of trouble. The other class, the good travellers, are those who get on with the people of the country, who bring back valuable scientific results, and so make it worth while for the officials and the people of the country to have helped them. I need hardly say that the Italians belong to the latter class. I had the pleasure of being Resident in Kashmir when the first Italian expedition, led by the Duke of the Abruzzi, came out. He established a tradition there of the way to treat the people, and that tradition was carried on by Dr. De Filippi, the Duke of Spoleto, and Professor Dainelli. I wish to thank you very much, Professor Dainelli, and congratulate you on the work you have so successfully accomplished.

The PRESIDENT: Dr. Longstaff's name in connection with these regions is one to conjure with. Dr. Longstaff.

Dr. T. G. LONGSTAFF: I had the pleasure of reading Professor Dainelli's paper before I came here, and there is very much more that he might have told us, and that we should have been glad to hear. It is too late to deal with most of the more technical and geographical points, but there are one or two which really must be emphasized.

The first point is that the one-hundredth part has not been told. It is a very remarkable achievement indeed to have spent two months on the greatest glaciers of the Karakoram, completely cut off for the whole time from all extraneous sources of supply. This demands extremely good preparation beforehand, and fine organization is evidenced by the achievement of landing the party, with all its supplies, on the Siachen glacier only two months after leaving Florence, quite apart from having maintained that caravan on the glacier for two months. One of the points that Professor Dainelli has not made is that the Nubra river rises in flood behind you. You get up there in June, if you are lucky, and then the Nubra river rises and you cannot get down. Therefore all supplies must be on the glacier for the whole season's work. Another difficulty was that Professor Dainelli had every intention of sending back twenty coolies, and keeping even fewer men than he did in fact keep. I am pleased that my friend remembered that, when he last saw me in Florence, before he started, he showed me the most beautiful sets of instruments in wonderful cases, and asked me what I thought of them. I advised him to leave them behind and take more food. If he had not done so I am sure he could not have succeeded. But the odd thing is that he seems to have done both, because if you read the paper you will find he took the instruments as well as the extra food.

The whole expedition exemplifies the advantage which a small party has over a large one in country where the difficulties of food supply are very great. I hope the President will not pull me up, but I must confess that I often feel rather

superciliously inclined when I hear about European transport officers and English-speaking interpreters. There are exceptional cases, of course, but there is to me a personally conducted tourist element about that. Unless you can penetrate somewhat into the lives of the native peoples it seems to me you lose half the delights of travel. Professor Dainelli's previous anthropological work had given him the entrée to an unusual extent. His expedition was a piece of real travel. Professor Dainelli had already wintered in Ladakh and Baltistan, as a member of De Filippi's expedition. He was his own transport officer and his own interpreter. He knows and likes the local people; and if they did not like him he could not have got such excellent service out of them. And what a compliment to Miss Kalau's character and capacity! To be the sole conductor of those subsidiary caravans over such glaciers and over ground which they did not know proves that she must have gained the confidence of those Ladakhs to a very remarkable extent. Those people will only follow some one in whom they have complete confidence.

I have been on part of the ground and it has been an extreme pleasure to see it again in those very wonderful photographs. It is, as Lord Conway has said, really as big an achievement to open one of these big Himalayan passes as to climb a big peak. The opening of this 20,000-foot pass between the Siachen and the Rimo glaciers is a fine alpine achievement. The Workmans, approaching from the Siachen side in 1912, declared that it was impossible. They denied the possibility of this route having been previously crossed by natives, as I had suggested in 1909, following of course the tradition recorded by Vigne in 1835, for the pass was not *known* to anybody. Dainelli has not only proved its practicability for capable mountaineers, but he found those tell-tale cairns which show that the pass had at some time or other been used by natives, probably in the time of Ahmed Shah or earlier. Nevertheless, for all practical purposes it is a new pass. I therefore consider the crossing of the Colle Italia to be just as great an achievement as the ascent of a great peak. I would draw attention to the fact that this is the first time that the main range of the Karakoram has been crossed between Younghusband's Muztagh Pass and the Karakoram itself—or, if you prefer it, the Saser—in either case a distance of 100 miles. It is really a remarkable achievement of Himalayan exploration, and I ask Professor Dainelli to accept our most hearty congratulations on the safe accomplishment of a difficult feat and on the solution of a puzzle which has intrigued us for so long. You continue, Professor Dainelli, the tradition of successful exploration and friendliness with the local people which the great expeditions of the Duke of the Abruzzi, of De Filippi, and of the Duke of Spoleto have accustomed us to expect from your compatriots.

The PRESIDENT: Professor Dainelli, you have heard three men pre-eminent in this country, mountaineers and geographers, speak with unqualified praise of the work which was done by the expedition of which you were the leader. It would perhaps be hardly becoming for one bred and almost born on the low level of the seas to attempt to paint those vivid colours as they have painted them, but I do, on behalf of the Society, wish to give you an expression of our admiration and thanks for what you have done.

I should like to take the opportunity of saying with what great admiration we all regard the fine Atlas of the Touring Club of Italy. If you will look at an enlarged map in the corner of Nos. 93 and 94 you will see a map of these parts. I was looking at it with the Professor yesterday afternoon and said, "That's an admirable map," and he replied, "Thank you very much. I made it." And that shows that what he brings back enables him to turn out excellent results; that his observations are recorded with great accuracy.

Dr. Longstaff, in that way in which he approaches the precipice of indiscretion and then stops, asked whether I was going to pull him up. I did not, but I have a small bone to pick with him, for he took from me the first mention of one who was the collaborator and the companion of the professor in his great expedition. That is some one whom I invite, if she will be so kind, to come and stand by me on the platform, Miss Kalau. When the flying caravans were organized and went out in various directions, Miss Kalau led one of them, and I am sure the ladies present will all applaud the fact that her caravan went much faster than anybody else's. The lovely photographs were all taken by her; and when all the collections of flowers are got out and tabulated the results will be mainly due to her care and energy in making the collections.

Professor Dainelli, I have one more duty to perform, and that is an extraordinarily pleasant one. It was unanimously resolved in Council this afternoon to invite you to become what we, perhaps in our conceit, may think is somewhat of a distinction, and what we know will be an honour to us, that is, an Honorary Member of our Society. I have the very greatest pleasure in offering you the thanks of this audience and of the Society, and of presenting you with this record of the fact of your Honorary Membership.

Professor DAINELLI: It is my duty to speak for various reasons, but all of these meet in the wish to express my gratitude. First of all to the President of the Royal Geographical Society, for the flattering words with which he has presented me to the audience. Secondly, to Lord Conway of Allington, to Sir Francis Younghusband, and to Dr. Longstaff, for the approbation they have given publicly to the expedition I have led in the Eastern Karakoram. It is an approbation of which I am particularly proud, as they have great experience of those mountain regions where my activity as a traveller has lain. It is therefore superfluous to remind the members of the Royal Geographical Society of the great explorations and topographical achievements of Lord Conway on the large Biafo and Baltoro glaciers. I am particularly grateful to him for saying that to-night's lecture has revived in him the remembrance of his explorations of forty years ago and has given him the impression of returning to that time; but this is probably not my own merit, but that of the pictures of those marvellous mountains which I was able to show you. It is also superfluous to remind any one of the successful explorations of Sir Francis Younghusband, who, about twenty-five years ago, after crossing a large part of Asia, near the end of his journey, encountered that yet unsurmounted obstacle, the Karakoram Range, and found in himself the courage to still more arduous exploration; he climbed the Shaksgam valley and the Urdok glacier until he came in view of the unknown Indira Col, then crossed the range by the unknown Muztagh Col, the first European to do so, and moreover without high-mountain equipment. I am glad if he thinks I have followed, though very modestly, in the tracks of his exploration. And to Dr. Longstaff I owe more particular thanks still: he is the real discoverer of the Siachen, and, by means of his great topographical sense, he was able to draw the sketch for a map of that immense glacier which, considering the brief time he spent there, seems a marvel of accuracy. He can realize above all others the difficulties of an exploration journey in that immense glacier world; and for this reason he has wanted to place in relief some of those he considers the merits of my expedition in meeting and overcoming these obstacles: a stay of two and a half months on the glaciers, the complete isolation towards the outer world in which I found myself, the persistence in my programme, namely to leave by a new way, which I had reasons to consider difficult. Of his approbation I must feel very proud indeed; but I must add that—if also in other circumstances I have always followed the rule to bring with me really everything that I considered

possibly necessary—in the case of my recent expedition I have followed this rule also on account of the recommendations of Dr. Longstaff, when, before my departure, he encouraged me to bring abundant quantities of food for the caravan.

But if all these were not reasons more than sufficient for my gratitude, another has now been added by the President in letting me know that the Council of the Royal Geographical Society, in to-day's meeting, has decided to make me an Honorary Member. And this I feel, and must say, is a greatly coveted prize for the activity which for more than thirty years I have dedicated to Geography, according to my feeble means, but, I can affirm, with great and never diminished ardour.

And, as many words cannot, I believe, express better this feeling of gratitude, I now have ended. But allow me to make still a kind of confession, which I might call a psychological one. When I left Florence to come to London, I felt some emotion: an emotion made of some anxiety and uncertainty, as must be felt by any one who, as a foreigner, is coming to speak in this Royal Geographical Society, which has so long and so glorious a tradition. And now that I must leave London to return to Florence, I also feel a deep emotion; but it is no longer one of anxiety and uncertainty, but consists only of that sorrow which is felt when parting from old friends. And also for this I want to thank the President and all his colleagues of the Royal Geographical Society, whose welcome and courtesies have taken from me the feeling of being a foreigner and have given me instead that of being a friend amongst old friends.

THE LAKES OF KENYA AND UGANDA, *investigated by the Cambridge Expedition, 1930–31 : A paper read at the Evening Meeting of the Society on 25 January 1932, by*

E. B. WORTHINGTON, M.A., PH.D., Balfour Student of Cambridge University

IN 1927 the Governments of Kenya, Uganda, and Tanganyika collaborated to make possible a fishing survey of the Victoria Nyanza. Mr. M. Graham, whom I accompanied, was lent by the Ministry of Agriculture and Fisheries for six months to undertake this work. Following after this in 1928 I made a similar survey of Lakes Albert and Kioga, concerning which I gave a paper to the Society on my return home. Since that time biological and geographical work has been done on the smaller lakes of the Kenya rift valley by Dr. Leakey's archaeological expedition and particularly by Miss Penelope Jenkin, the results of which were described to the Society last year by Dr. Leakey (*G.J.*, vol. 77, 1931, p. 497). Prior to all this the great lakes to the south, Tanganyika and Nyasa, had been studied by the several Tanganyika Expeditions 1895–1905, and also more recently by Dr. Christie; but there remained several great water areas which were almost untouched from the biological point of view, and whose actual outlines were sketched in on maps with no great precision. Accordingly another expedition was arranged to attempt to fill in the map, and as a result it may now be said that thorough biological surveys have been made on all the important lakes in Kenya and Uganda.

Work of this type is essentially a combination of the several sciences of Geography, Biology, Geology, and Chemistry, and previous experience had shown how little one man alone can do with all these subjects in those parts of Africa where so much time must be given over to arrangements of transport, camping, native labour, and so forth. Therefore, on this last expedition, which was called the "Cambridge Expedition to East African Lakes," there were several of us: Mr. L. C. Beadle, of Pembroke College, as Chemist and Zoologist; Mr. V. E. Fuchs, of St. John's College, as Geologist; myself, of Caius College, and, after the first three months, my wife, of Newnham College, as Geographers. Also for the first two months we were accompanied by Captain R. E. Dent, Fish Warden in Kenya Colony, whose experience of the country was invaluable. Sufficient money was contributed by scientific bodies in this country: the Royal Society from Government Grants, the British Museum of Natural History, the Percy Sladen Memorial Trust, the British Association, the Balfour Fund, the Royal Geographical Society, Gonville and Caius College, and the Geological Society. The Uganda Government also contributed. Accordingly in October 1930 we set out, having an unattractive voyage to Mombasa, third class in an overcrowded ship.

Lake Rudolf

The main objective was Lake Rudolf in the desert region of northern Kenya bordering on the Sudan and Abyssinia; but in addition we worked on lakes Baringo, Nakuru, and Naivasha farther south in the Kenya rift valley, and during the last six months in Uganda we studied Lakes Edward and George in

the great rift valley at the foot of Ruwenzori. Last of all, my wife and I spent an extra six weeks on lake Bunyoni in the highlands of the Kigezi district, a series of swampy lakes between Edward and Victoria, whose names are Nakavali, Kachira, and Kijanebalola, and on lake Nabugabo at the north-east corner of the Victoria Nyanza. These smaller lakes were examined for the Uganda Government with a view to the possible introduction of fishes for economic use.

Lake Rudolf, a great mass of water at 1250 feet above sea-level, 185 miles long with a maximum width of 37 miles, lies on the meridian of 36° E. between the latitudes of 2° 30′ and 5° N. Although Lake Rudolf is marked "salt" on many maps there is a much higher proportion of soda than of salt in solution, making the water exceedingly unpleasant to drink. Lake Rudolf was the last of the Great African lakes to be discovered. Count Teleki was the first white man to reach it in 1885, and the book on his expedition by von Hohnel ('The Discovery by Count Teleki of Lakes Rudolf and Stefanie,' 1894) contains one of the best descriptions of the lake and surrounding country yet written. Teleki arrived at the lake with a huge caravan after a long waterless march from Baringo, and so he and his men were compelled to drink the untreated lake water, with dire results. The native fishermen round the shore drink the water readily if they cannot obtain fresh water, but those unaccustomed to it find the soda overpowering. On several occasions during boat expeditions we were reduced to nothing but lake water, but by treatment with the requisite proportion of citric acid we produced a drink which was refreshing, though medicinal.

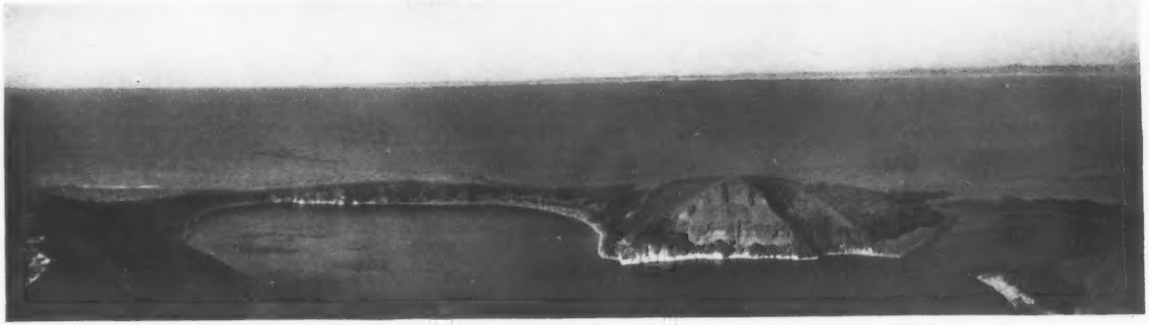
We had to take with us to Lake Rudolf a boat sufficiently large and sturdy to withstand storms and the heavy swell which is a permanent feature of the open water, and therefore could not take the direct caravan route to the southern end of the lake which was adopted by Teleki, and by others since his discovery. Instead we had to go through Kitale, whence a so-called road runs north-west across the Sukh and Turkana plains, down two escarpments and so to the northern frontier of Kenya, to the military outpost of Lokitaung. We reached the lake at the mouth of the Kaliokwell river on the shore of Ferguson Bay, which is 50 miles beyond the district headquarters of Lodwar. There we made our base camp, and with the aid of a considerable number of native Turkana we launched the 20-foot metal lifeboat lent to the expedition by the Government. We built a house out of brush-wood and palm leaves, and made ourselves as comfortable as possible in a temperature which reaches 105° F. in the shade every day, and a strong wind which blows almost consistently from the south-east. The 300-mile journey by lorry from Kitale to the lake could be made under favourable conditions in three days, but on one occasion we returned just after the annual heavy rains when the rivers, usually dry sand, had just come down in flood, and we had to spend six nights on the road.

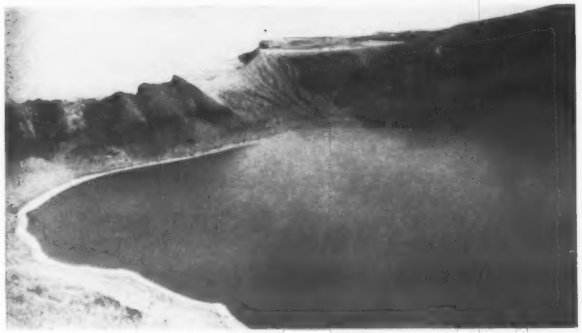
The site of our base camp had the advantage of being partly sheltered by a sand-spit some 10 miles long forming Ferguson Bay, for the big seas from the south-east present a formidable obstacle to small boat navigation. On one crossing of the lake, for instance, we experienced a swell which we estimated to be at least 60 feet from crest to crest. With the aid of a 12-h.p. outboard motor, which propelled our craft at a speed of 4 or 5 miles an hour, and by picking our weather we were able to visit all the lake shores and to work the

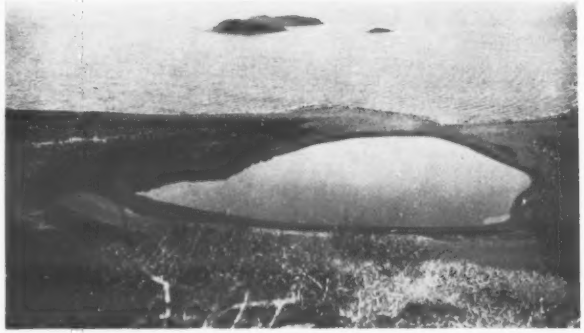
Lake Baringo from the west shore, showing recent rise in water-level

The water-lily fringe of Lake Bunyoni

Vegetation in a dry Turkana watercourse







Three views from the summit ridge of Central Island, Lake Rudolf; Crater lake A above, B left, C right

open water between the latitudes of 3° 5′ and 3° 40′ N. Owing to lack of space for water, petrol, food, and collecting gear, our cruising range was limited, and we were unable to visit the north and south ends of the lake.

Unfortunately Mr. Fuchs was unable to accompany the expedition during the greater part of our time on Lake Rudolf during March and April 1931, since he was at the time suffering from a bad attack of Spirillum fever and malaria, but by then my wife had joined us and took over the work of surveying the parts of the lake with which we were particularly concerned. She made plane table and compass surveys of Ferguson Bay and Central Island: the resulting map is reproduced here as Map 1.

The escarpments of the northern part of the Kenya rift valley in which Lake Rudolf lies are much broken up, and the rift itself is wider than farther south in the better-known parts near Naivasha and Nakuru. The middle section of the lake where our work was carried out is bounded on the east side by the escarpment wall of the valley which rises more or less sheer from the water, but on the west the escarpment is set back from the lake shore some 60 miles, the intervening area being occupied by the Turkana desert which is itself broken up by hills.

The most important affluent of the lake is the Omo river which enters at the extreme northern end and is fed by a number of tributaries from the Abyssinian highlands. All the other rivers flow through desert regions before reaching the lake shore.* Of these the largest is the Turkwel, whose chief headstream is the Swam, rising on Mount Elgon. This river only flows intermittently at Lodwar, the district headquarters some 40 miles from the lake shore, and even in the wet season it seldom reaches the lake itself on the surface. We cruised down the lake shore during the wet season on purpose to investigate this point, but were quite unable to find the river's mouth. All the other rivers are dry watercourses in their lower reaches except at very rare intervals. The Kaliokwell, for instance, was dry whenever we were on the lake, but there was ample evidence along its banks that occasionally it comes down in a prodigious torrent. Underground water gives rise to exuberant vegetation of dom palms and mimosas along the river-beds. On one motor journey over the Turkana plains we had the good fortune to see one of the rivers actually coming down. We crossed the dry bed late one evening and camped on its bank. At about 10 p.m. we heard a rushing noise, and on running to the river bank saw a white foaming torrent approaching at about 10 miles an hour in a huge wave carrying away bushes and logs of wood in its course. For a few minutes it increased in volume and it flowed during most of the night; by dawn however the river-bed was again dry except for a few pools of muddy water.

Along the lowlying western shore of the lake the prevalent south-east winds have built up a series of sand-spits similar to those of Lake Albert described by me in 1929 (*G.J.*, vol. 74, 1929, p. 109), but on a much larger scale. Three of these spits are sufficiently large to alter the even line of the lake shore: a spit which forms a bay near the mouth of the Turkwel river; the Ferguson spit of Map 1; and a long spit towards the north end of the lake which encloses the

*Captain John Yardley, D.S.O., 'Parergon or Eddies in Equatoria,' 1931, states (page 138) that the river Kibish, which enters the Saunderson Gulf from the north, was flowing throughout the year in 1917.

Saunderson Gulf. On the east shore there are more sand-spits, the most prominent of which is one extending a good 5 miles into deep water at the foot of Mount El Moitat.

During recent years, since the lake was discovered, the shore-line seems to have changed considerably by the growth of these sand-spits, and probably also by a slight lowering in the general water-level. The Saunderson Gulf, for instance, which had an area of more than 200 square miles as lately as 1918, is now almost dry; and Ferguson Bay appears to have changed in shape, if the previous survey by the military authorities in 1921 is reliable (see inset to Map 1). The most noticeable change is the further growth of the sand-spit which now encompasses the island once lying off its tip.* Ferguson Bay is itself a big stretch of water having an area of roughly 11 square miles and consequently has a set of wind and wave currents of its own. These have resulted in the growth on its inner side of a system of a dozen or more small spits, hooking round on themselves in various ways, and illustrating very clearly the effect of local wind and wave action on a sandy shore-line. Off the extreme northern end of the spit there are big areas of shifting sand more or less exposed, showing that the spit is still rapidly growing northward into the lake. The gulf was sounded in some detail and is quite shallow, with a maximum depth of 5·7 metres.

Another good example of changing shore-line is a little shingle spit at the north-western extremity of Central Island. On our first visit to the island in December 1930 the winds were blowing from the south rather than the east, causing a strong eddy round the south and west shores of the island, with the result that the shingle spit hooked round to the north, forming a perfect little harbour on its northern side. In March 1931 however the winds were blowing from the east rather than from the south, with the result that the eddy wind round the island came from the opposite direction and the spit had been shifted bodily, forming a harbour on its opposite southern side.

Central Island had never before been visited, but was inserted in the maps as a roughly conical mass almost exactly in the middle of the lake, with two rocky islets off its south-east corner. The expedition paid several visits to this island and found it to be a most interesting place with a wild shore-line, in some parts composed of vertical cliffs and in others of black lava shingle. The island is roughly 2 miles square with a central ridge rising to 600 feet above lake-level, but it is by no means a simple conical volcano as it appears from the mainland. It is cut up by a number of extinct craters, some of which are now occupied by lakes at about the same level as that of Rudolf itself. The largest lake (A), near the west shore of the island, has steep sides rising abruptly to 550 feet, and shows distinctly its derivation from three craters.

To the north-east of crater lake B there is a system of sulphur fumaroles, from which still issue sulphur fumes and volumes of smoke. Central Island forms one of the system of volcanoes down the very centre of the Kenya rift valley. Others in the same series are North and South islands in Lake Rudolf, Teleki's volcano on the south shore of the lake, the volcanic islands in lake Baringo, Menengai crater near Nakuru, Crescent island in lake Naivasha, and

*This sand-spit island certainly existed up to 1918. It is mentioned by Yardley (*loc. cit.*) and H. Rayne, *Journ. African Society*, 1918–19, p. 254.

still farther south, Mount Longenot. Of these only two are still active so far as is known—Teleki's volcano and Central Island.*

We sounded the open water in the neighbourhood of Central Island and the results are plotted on the map. Between the island and Ferguson spit there was a maximum of 56·7 metres, but on a line due north from the island our lead descended to 73 metres. Midway between the island and the west shore of the lake we found 58 metres. From these soundings it appears that some parts of the lake are likely to be rather deeper still, but owing to the heavy seas we were unable to sound farther afield.

The water in the crater lakes on Central Island is different from that of Lake Rudolf itself. It has a much higher alkalinity and salt content, and is unfit to drink; it differs also in the extremely dark green colour due to minute algae. Feeding on the algae are several kinds of fishes and feeding on the fishes there are innumerable crocodiles and great water tortoises (*Trionix*) which weigh up to 100 lb. or more. Around the shores are many water birds—flamingoes, spoonbills, pelicans, cormorants, Egyptian geese, Caspian tern, and several kinds of small waders. So far as we could find there are no mammals on the island, but there are plenty of lizards, a few snakes, and little birds, including Richardson's Pipit and a Finch-lark. The remarkable thing about the animals of the island was their astonishing tameness. Stepping on to the shore we were reminded of Charles Darwin's account of the Galapagos islands. We erected our camp beds on the shingle, close to the water's edge, and in the morning little birds came hopping round, settling on our beds. The crocodiles were still more remarkable in this way; we were able to walk up close to them as they basked on the shores of the crater lakes: a great contrast to the crocodiles near our base camp, where they are persecuted by the Turkana for food and are almost impossible to shoot and quite impossible to photograph. The Central Island crocodiles however, having never seen man and having no other enemies, showed no interest at our approach, and on occasions we threw stones upon their heads from two or three yards' range before they would consent to move from their hiding-places into the open to be photographed.

In spite of their complete adaptability to water life crocodiles do not seem to traverse big stretches of open water, and so these tame crocodiles must have lived for many generations without mixing with those of the other shores of Lake Rudolf. Another instance of this is to be found in Lake Victoria. Almost in the middle of that lake a little island called Godsiba is entirely free from crocodiles, and consequently it is possible to bathe there with impunity, although all other parts of the Victoria shores are very dangerous. In this case the nearest mainland is 36 miles away and the crocodiles have never traversed this stretch of open water.

The fishes of Lake Rudolf are exceedingly numerous and many kinds are represented, ranging in size from the great Nile Perch down to minute fishes whose adults are no more than 2 inches long. In studying the ecology of the lake we came to the conclusion that of all the many varieties of fish the largest

*Captain W. P. Holland ("Volcanic action north of Lake Rudolf in 1918," *G.J.*, vol. 68, 1926, p. 488) refers to other volcanic action in the Rudolf region, and a note by the editor following the paper mentions the replacement of Teleki's volcano by Mt. Lutter, some three miles farther south.

and the smallest are most important. The Nile Perch, of which we caught large numbers, including a specimen 6 feet 2½ inches long, weighing 214 lb., is supreme, having no enemies apart from crocodiles, which as a rule are too sluggish to capture it. The smallest fish, a new species of *Engraulicypris*, is abundant everywhere in huge numbers; its role in the ecology is to feed upon the minute crustacea and other planktonic organisms and so to put this potential food supply into a form available for larger fishes. Between the *Engraulicypris* and the Nile Perch there are several links in the food chain of which the most important is the small Tiger fish (*Hydrocyon forskalii*) which measures about 1 foot long and weighs about ½ lb.

Taking the fish fauna as a whole it shows remarkable similarity to that of Lake Albert at the head of the White Nile, a type of fauna which is found also right down the Nile as far as the delta. Lake Rudolf is now an enclosed drainage basin, but since this type of fauna is found nowhere else in Africa it is certain that Lake Rudolf was once connected to the Nile itself.

One of the objects of the expedition was to investigate the old beach levels round the lakes and so to work out the previous distribution of land and water during the great pluvial periods. We examined several such beaches near the Rudolf shores, the highest and most important of which we measured to be about 500 feet above present lake-level. This is evident on the west shore of the lake, and on the east shore opposite Central Island there is a well-marked wave cut level at about the same height. Unfortunately, owing to the failure of our aneroid barometer, we were unable to determine the height of this, but estimated from photographs it comes out at 475 feet. If there have been no marked earth movements in this part of the rift valley since the pluvial periods, the lake when at the level of these high beaches must have covered a vast area of the Turkana plains and probably was at the height of the watershed to the north-west which divides the lake basin from that of the Sobat river. We may therefore conclude provisionally that during the pluvial periods the lake was drained by the Sobat river from the north-west end into the White Nile south of Khartoum.

Natives living on the lake shore depend very largely on fish for their food supply. A small tribe called the Elmolo, who inhabit the Southern or Elmolo island and also a few places along the south-east shore of the lake, are said to have no other diet at all. In the past they have been much persecuted by the neighbouring tribes and suffer from disease, undoubtedly due to lack of suitable diet. By all accounts their numbers are fast being reduced and in a few years' time the tribe will be extinct. North of the Elmolo the eastern shore-line as far as Alia Bay is entirely devoid of inhabitants. On the west shore however there is a population of Turkana which is in places quite dense, particularly near the mouth of the Turkwel river, where they cultivate a stretch of sand along the extreme shore-line and grow a poor quality dhurra. In the neighbourhood of Ferguson Bay there is no cultivation, but the Turkana have herds of goats, sheep, camels, and a few cattle, which browse on the vegetation near the river-beds and on the spiny grass growing in a belt along the lake-shore. The fishermen seem to be a separate community, and their diet consists almost solely of fish and the nuts of the dom palm, from which they scrape off the outside soft covering. Their fish baskets have very wide mouths

and a hole in the top. Gangs of twenty or thirty men drive the fish into little inlets of the shore and in the shallow water plunge their baskets on to the bottom. If they catch a fish it is due to good luck rather than good management. Some of the more enterprising fishermen locate the nests of the big *Tilapia nilotica*, mark them with sticks and visit them regularly with their baskets. The fishermen also catch Nile Perch with long-shafted iron hooks, a method which now seems to be confined to the north end of the lake. The Turkana have no canoes, but occasionally make rough rafts out of driftwood which are only of use in quiet water close to the shore.

By trying out various fishing methods we found that quantities of large fish could be caught very easily, and when communications are more satisfactory there will be an opportunity for a large-scale economic fishery.

Very little has been written about the Northern Turkana tribe, the only paper on their ethnology is a short one by E. D. Emley (*Journal Royal Anthrop. Inst.*, lvii, 1927), a district officer who was stationed at Lodwar in 1926. The Turkana belong to the group of East African peoples designated with the Sukh, the Nandi, and Marsai, as "half semitic." They usually attain a fine stature. They are essentially a nomadic people and, living in a country where there is practically no rainfall and very little grazing, are constantly on the move. Their huts are small shelters made of wattle and palm leaves, open on the lee side. These huts are erected in an hour or two and are just sufficient to afford shelter from the terrific sun and the powerful winds and blown sand.

Artistically, the Turkana are poorly developed in most respects. Their dances, which we had several opportunities of observing, consist for the most part of running round in circles, the only variant of footwork being a double, rhythmical stamp on each foot. They are adepts at animal mimicry and have special dances representing most of the wild and tame animals in their country. The best of these is the giraffe dance in which a group of men, outstanding in stature, characterize giraffes by raising one hand with the fingers outspread for the head and neck, and mimicking the typical lope of the giraffe in running. This representation is extraordinarily accurate, and the finishing touch is provided by the free arm which is clasped behind the body and waved in that peculiar fashion of the giraffe's tail when the animal is frightened. In the giraffe dance, as in the other wild animal dances, one or two men of short stature mimic the hunter and run round after the giraffe men in crouching attitudes. The dance usually ends in a mimic kill. The dancing is invariably accompanied by chorus singing in which the Turkana surpass most other tribes. On hearing a male chorus for the first time one is reminded of the European sea shanties, the shanty-man chanting a falsetto solo followed by a deep base chorus from the multitude. There is a special song for each animal, several of which we were able to record, in so far as they can be written in European musical notation.

The shores of Lake Rudolf are not rich in great game animals owing to their aridity. Formerly elephants used to descend the Turkwel river on to the Turkana plains. On the west shore of the lake there are considerable numbers of the pale desert variety of Grant's gazelle, a few leopards and cheetah, and dik-dik along the dry river-beds. Farther north, where there is mountainous country close to the lake shore towards the Abyssinian border, there is more

game, and in the rocky regions there are still large numbers of klipspringers. On the east shore there is much more game: we saw there herds of oryx, many Grant's gazelle and hartebeest, zebra, giraffe, and plenty of leopard and lion spoor. Along the sand-spit at the foot of El Moitat there were also vast herds of hippopotamus and flocks of Egyptian geese and whistling ducks. This area is quite untouched by the sportsman since it is only approachable by boat. It comes into the region of the Northern Frontier Province of Kenya, which it is proposed to convert into a National Park. The stretch of the eastern shore from El Moitat to Alia bay has not previously been visited, since in places the mountains descend precipitously to the water. This caused Teleki and other travellers to make a wide detour inland.

Lake Baringo

Lake Baringo, a much smaller rift lake lying far to the south of Rudolf in latitude 0° 46′ N., and longitude 36° 15′ E., was also investigated by the expedition. It is much easier of access by a road nearly all the way up the rift valley from Nakuru. The lake is about 12 miles long by 6 miles wide, at a level of 3150 feet. There is one large and several small volcanic islands near its centre which rise abruptly from the yellow muddy water. The lake had not previously been sounded in any detail, so it was rather a surprise to find that nowhere is it more than 7½ metres deep. The lake floor is apparently level at this depth almost all over, shallowing close to the shores. From the flat bottom arise the volcanic islands composed of trachyte, forming the eroded remains of ancient volcanic plugs. On the shores of the largest island there are a number of boiling sulphurous springs, described by Major Powell-Cotton (*G.J.*, vol. 24, 1904, p. 56). We found in these springs a very high proportion of alkaline salts, and with other hot alkaline springs at the south-east corner of the lake they must put a great quantity of salts into the lake water. As lake Baringo has no apparent outlet it is rather surprising that the water is comparatively fresh. Professor Gregory supposes a subterranean outlet: "At several points along the north-east shore I observed, in May 1893, the water pouring freely into the lavas" ('The Rift Valley and Geology of East Africa,' 1921, p. 107). The lake level has risen considerably in recent years, as dead trees of a species which can only live on dry land still stand in water 3 or 4 feet deep. This may account for the fact that we were unable to find the outlet observed by Gregory. On one of the rocky islets we were able to measure a number of previous lake levels, probably of recent date, at heights of 8½ and 16½ feet above present water-line.

The fish fauna of lake Baringo is poor compared with that of Rudolf. One or two species, in particular a *Tilapia* and a *Barbus*, are present in great numbers, but unfortunately they have an unpleasant flavour due to the muddy water. The natives inhabiting the lake shores and the largest island call themselves Njemps and are in reality a derivative of the Marsai. They are cattle owners, but some devote themselves to fishing. They have no fishing nets and apart from spearing cat-fishes at the river mouths they have only one method of fishing: they locate the *Tilapia's* nests in the shallow water and mark them with sticks, then they wade about, showing no fear of the innumerable crocodiles, tie a dragon-fly on to a small barbless hook, and dangle it over the nest. It is

evident that this catches only the shallow-water fish. The mass of fish at present quite untouched in the open water offers an opportunity for economic fishing.

The Njemps' craft on lake Baringo, although canoe shaped, is really a raft made of the cork-like Ambatch wood. The natives do not make paddles but propel the craft with their hands aided with flat pieces of wood.

The crocodiles of lake Baringo are small, rarely exceeding 8 feet, and have sometimes been described as harmless. This is not so however, for it was my misfortune to have to treat a small boy who had been badly mauled by a crocodile while watering goats. The boy had been taken by the chest and both arms and his sides were torn so that they exposed the ribs. Unpleasant though the treatment was, since the wounds had been left to themselves for more than a week, it was gratifying to see the native powers of recuperation responding to a little antiseptic.

Baringo is a charming lake to view from a distance, from the heights of the escarpment, but owing to the enormous numbers of mosquitoes breeding along the lake shore it is by no means pleasant camping within several miles of the water. Curiously enough the rocky islands are nearly free from mosquitoes, and Beadle and I spent quite a comfortable week on one of them while working the open water.

Lakes Edward and George

The work in Uganda during the last six months of the expedition was carried out by arrangement with the Uganda Government, who provided all our transport and in return received reports concerning the fish resources of the large lakes and proposals for introducing useful kinds of fish to some of the smaller lakes. Lakes Edward and George lie in the great rift valley of Central Africa where it is complicated by the massif of Ruwenzori. The main valley runs south-west from Lake Albert and then narrows to the region at the north end of Lake Edward, and continues south to the Mfumbiro volcanic mountains and lake Kivu. There is an arm of the rift to the south-east of Ruwenzori which includes Lake George and the Kazinga channel. The escarpments are therefore somewhat complicated in this area. On approaching the Kazinga channel by road from Mbarara, just before descending the escarpment at Kichwamba, one can see in clear weather Lake George and Lake Edward laid out in the plain below: to the north-west the great mass of Ruwenzori surmounted by two of the three snow peaks seems to pierce the sky, and still farther away, looking due west, the high escarpment which forms the west shore of Lake Edward can be dimly discerned.

Lake Edward, which is 48 miles long by 25 miles wide, has its longer axis north-east to south-west. The south-east shore is flat and swampy, but on the west shore the Congo escarpment descends abruptly to the water. The main affluents are the Ruchuru at the south end which drains the Mfumbiro range and parts of the Kigezi highlands, and a series of rivers along the south-east shore flowing also from Kigezi, the most important being the Ishasha, which forms the Congo–Uganda boundary, and the Ntungwe. There are only three small islets in Lake Edward which lie in Katwe Bay at the north-east corner: they are of volcanic origin.

While my wife and I were camped in July 1931 at the source of the Semliki,

which drains Lake Edward at the northern end, we took the opportunity of measuring the flow of the river. We fixed a rope across the river at right angles to the flow some 50 yards downstream from the actual exit from the lake, at a point where the river's width is 71 metres. We measured the depth of the river every 3 metres, and so after measuring the speed of flow (average 0·9 metre per second) were able to calculate the flow of the river to be 103·3 cubic metres per second. This compares well with the previous estimation made by Sir William Garstin in the dry season of 1903: he found the flow at the head and tail of the Semliki to be respectively 97 and 124 cubic metres per second.*

The Kazinga channel, whose length is about 30 miles, is about half a mile wide with steep banks, and is supposed to drain Lake George into Lake Edward. Lake George itself is about 12 miles square with a large bay on the west side reaching to the foothills of Ruwenzori. The escarpment is only a few miles away from the east shore, but a huge papyrus swamp forms the northern shore and extends for 15 miles up an arm of the rift valley. Most of this swamp is at present a Game Reserve.

Owing to outbreaks of sleeping sickness some years ago the entire native population was removed from the Edward and George region by the Uganda authorities, and quite recently the Congo authorities have removed the inhabitants from the west shore of Lake Edward for the same reason. In consequence the only places where natives are allowed now are small areas which are kept clear of vegetation. There are clearings on both sides of the Kazinga channel at Katunguru where there is a motor-car ferry; at Katwe on Lake Edward, where there is a flourishing salt industry; and on Lake George there are clearings at Kisenyi whence salt is ferried across the lake to Mayura for distribution in the Toro district. The only other clearing is at Mohokya at the extreme western end of Lake George where there is a native fishing industry.

All the other shore-line is in sleeping-sickness area and is therefore given over entirely to wild life. In the forests and park-land adjoining the shores there are huge herds of elephant, buffalo, water buck, Uganda cob, and smaller buck, the great carnivores abound and the shores are infested with hippopotami whose dung is washed up by the waves and lies a foot or more deep in places. Crocodiles are entirely absent from both lakes, a remarkable fact which is referred to later in the paper.

Since the winds in the Lake Edward portion of the rift valley are not so regular or so powerful as those of Lake Albert to the north or Lake Rudolf in the Kenya rift, conditions are not suitable for building long sand-spits extending into the lake as they are in these other two lakes. Instead, regular wave action has built up a sand-bar from 5–30 yards wide all along the shore. On those parts where flat or swampy land intervenes between the lake and the rift escarpment this sand-bar shuts off the swamps from the lake itself. Thus it is possible to walk along the shore in many places with the lake on one hand and several miles of quagmire on the other. In certain places the sand-bar extends into the lake a little way, forming lagoons narrowly separated from the lake itself, as for instance at Kanyamwongo and Kisenyi on the eastern shore, and at Kaianda at the extreme north corner of the lake just on the Uganda side of the international boundary.

*Hurst, "The Lake Plateau Basin of the Nile," vol. ii, p. 42.

The north-east corner of Lake George

Lake Katwe

Ferry across the Kazinga channel at Katunguru

Head-dresses of Turkana men; warrior to the left, chief to the right

Kaianda was visited by Beadle and Fuchs, who found a small native fishing settlement on the sand-bar which is there about 30 yards wide. The lagoon behind the bar is about half a mile across and 1–1½ metres deep. Although the effect of wave action is to close the lagoon completely, the natives keep narrow channels open for the passage of fish, and so the shallow lagoon keeps up a plentiful supply which the natives drive into corners and capture with hand-baskets. These hand-baskets are of the type used by the Turkana fishermen of Lake Rudolf, with a hand-hole at the top for extracting the captured fishes. The spits on the east shore of the lake at Kisenyi and Kanyamwongo also subtend lagoons of a metre or so in depth, but have not yet closed them off from the lake itself. Our observations along this shore showed however that the sand-bars have grown very considerably since the Uganda–Congo Commission Survey of 1906–8.

Vegetation behind the swamps on the lowlying shores of Lake Edward consists of grass-land with scattered trees and patches of dense forest. Along the Congo escarpment however the vegetation is quite different: there is a strip of forest along the rocky shore, the high escarpment behind being covered with bare grass. In those parts where the lake is bounded by a vertical cliff there are magnificent torrents pouring down the rocky face.

During the dry season visibility in the Lake Edward basin is extraordinarily poor. My wife and I made a three-weeks' trip by boat round the lake and crossed it from east to west near the south end. The width in this part is 17½ miles and the speed of our laden boat was 4½ miles per hour. After half an hour's sailing the east shore was entirely obliterated by mist, and for three hours we had to steer by compass before the wall of the Congo escarpment loomed up when we were within 2 miles of the western shore. From there we travelled north under the Congo escarpment and were struck by the inaccuracy of the existing maps. About every 10 miles there are rivers entering the lake: these have built up little fans of flat land below the escarpment. Bananas had been planted on every possible patch of ground, but there was no native to be seen. Herds of elephants were browsing in the deserted banana plantations, and at every landing we were struck by the enormous numbers of tsetse flies. Afterwards we found out that the Congo authorities had just removed the entire native population owing to an outbreak of sleeping sickness.

The extension of the Kenya and Uganda railway has been projected from Kampala to run past Lake George and Lake Edward and so into the Congo, but for reasons of economy the work has been postponed indefinitely. At present therefore the approach is by road through Masaka and Mbarara to Katunguru. By now a new road is complete from Katunguru northward past Mohokya to join up with the old road at Fort Portal, which is the provincial headquarters. The only approach to the south end of Lake Edward is through the Parc National Albert reaching the lake at the mouth of the Ruchuru River, a route which is well described by Professor Julian Huxley ('Africa View,' 1931).

There is some discrepancy in figures for the heights above sea-level of Lakes Edward and George. According to the Uganda Congo Commission, 1906–8, Lake Edward lies at 3000 feet and Lake George at 3016 feet. A line of levels taken recently by the Railway Survey with a view to projecting the Uganda

railway into the Congo has corrected these figures to 2995 and 3009 feet, but even these seem very improbable for the following reason. According to Hurst ('The Lake Plateau Basin of the Nile,' vol. i, p. 14) a difference in 16 feet level between the two lakes "would imply a mean velocity of 3 or 4 feet per second and a discharge of the order of 3000 cubic metres per second." During the expedition we were camped at the mouth of the channel into Lake Edward for several weeks and there was never an appreciable current flowing into the lake.

The water of Lake George and the Kazinga channel is much less alkaline than that of Lake Edward, 0·002 compared with 0·01 normal. This causes a difference in the microscopic plant life of the two kinds of water, so that Lake George and the Kazinga channel are green owing to the abundance of microscopic plants in the water, while Lake Edward contains perfectly clear water. There is an obvious line of demarcation between the two types of water, and this line sometimes moves 200 or 300 yards into Lake Edward and sometimes the same distance into the entrance of the channel, according as the wind blows from the lake or from the channel. Furthermore current bottles floated in the channel sometimes moved toward Lake Edward, sometimes toward Lake George. We can therefore state definitely that from June to August 1931 there was no appreciable current flowing down the Kazinga channel and consequently there cannot be more than a foot or two's difference between the levels of the two lakes. Nevertheless the water movement must be on the whole in the direction of Lake Edward, since the line of demarcation between the two types of water is at the Edward end of the channel.

Lake Edward had not been sounded before, but was generally supposed to be quite shallow. During boat expeditions on the lake we sounded whenever opportunity offered, and the results are shown in Map 2. The whole of the east side is certainly shallow, but we found the floor of the lake to slope evenly down towards the west, where unexpectedly our lead descended to a maximum of 117 metres, within 2 miles of the Congo escarpment. As a result of the soundings we were able to insert the depth contours with some degree of accuracy. These show very distinctly the gradual slope of the lake floor from east to west, the deepest part of the lake being close to the Congo escarpment. The sloping plane of the lake floor is continued to the east on the lowlying land between the lake and the escarpment of the Kigezi highlands. This is shown in a section across the rift valley passing through the deepest part of the lake (inset to Map 2).

The Kazinga channel is quite shallow, ranging from 3–4½ metres deep, and the whole of Lake George is shallower still with 2·6 metres, except a little crater at the extreme south end narrowly joined to the lake itself, where we found 6 metres. Thus we reached the conclusion that if some dynamite were used to lower the rocky barrier where the Semliki runs out of Lake Edward the whole of Lake George would be drained, leaving in its place a flat fertile plain cut by a river; or conversely a small dam across the Semliki source would flood great areas of lowlying land bordering Lake George and the south end of Lake Edward. It is not considered that either of these possibilities would improve the country, but they are suggested to illustrate the physiography of the lakes.

Fauna

An object of the Cambridge Expedition was to work out the past history of the great lake regions by studying the present distribution of the aquatic faunas. In this connection Lake Edward is particularly illuminating. The waters of East Africa as a whole may be divided into two distinct types : in Lake Albert, the Lower Nile, and Lake Rudolf there is one type of fauna, marked by its variety and in particular by the presence of a number of genera of fishes of which the most important are the Nile perch (*Lates*), Tiger fish (*Hydrocyon*), and *Citherinus*. In the other type of fauna present in the Victoria Nyanza, Lake Kioga, the Victoria Nile above the Murchison Falls, and Lakes Edward and George these genera of fishes are absent, but a few genera, notably *Haplochromis*, have evolved a large number of similar species. Edward and George are peculiar also in their lack of crocodiles. This absence of crocodiles has been much discussed and various suggestions have been made to account for it. Some people have maintained that there is in Lake Edward some chemical or other substance toxic to crocodiles, or that the conditions are in other ways unsuitable. Other people have held that the distribution of crocodiles was established before the formation of Lake Edward, and that since the Edward basin has been occupied by water, crocodiles have been prevented from reaching it by waterfalls on the river Semliki. During the expedition Beadle investigated the water chemistry and found nothing that could possibly prevent crocodilian life, and concerning the other hypothesis we made some discoveries which throw light on the problem.

By good fortune there is along the shores of the Kazinga channel a deposit of Kaiso age (Middle Pleistocene) similar to the well-known Kaiso bone beds of Lake Albert, and Fuchs made a special point of collecting fossils from this bed. In it he discovered a number of crocodile teeth and scales, showing that although Lake Edward is now free from crocodiles it has not always been so. Moreover he found a large fish fauna consisting of *Lates* and several other of those genera which are mentioned above as being absent from Edward, Victoria, etc. Thus, there is no doubt that in Kaiso times the fauna of Lake Edward was very similar to, if not identical with, that of Lake Albert and the Lower Nile. Some drastic change must have occurred in the lake basin which exterminated crocodiles and the entire existing fauna from the lake, and as the most reasonable explanation I suggest that violent desiccation, which is known to have taken place after the first and greatest of the pluvial periods, must have dried up the Lake Edward basin completely. With the oncoming of another wet period, the Edward basin again became a lake and its existing fauna found its way in, probably from the east, from the Victoria Nyanza.

It might be urged that Lake Edward, being the deepest lake in either Kenya or Uganda, is less likely to have dried up during the arid interpluvial period than any other lake, but as an explanation I suggest that Lake Edward has not always been deeper than the others. It is well known that the rift-forming movements took place slowly, rather than suddenly all at one time, and they may still be continuing, as instanced by the recent earthquake in 1927 in the Kenya rift valley. The section (inset Map 2) shows that the floor of the Edward rift valley has been tilted more or less uniformly, and I suggest that this tilting took place after the desiccation of the lake. The lower reaches of the Semliki

river near Lake Albert abound with crocodiles which extend up the Semliki as far as the so-called Semliki falls, some 30 miles down the river from Lake Edward. These falls doubtless form the barrier to further migration of crocodiles and the Lake Albert fishes, and have prevented them from re-entering Lake Edward.

It has been maintained that waterfalls are no barrier to crocodiles, and certainly crocodiles are found above and below the Murchison Falls on the Victoria Nile which are very much larger than the Semliki falls, but in order to investigate this point Beadle and Fuchs made a special trip to the Semliki falls, while my wife and I were occupied with a boat expedition to Lake Edward. They found that the river runs through a deep rocky gorge for several miles, and that the surrounding country is dense impenetrable forest. It seems that the rapids themselves are sufficient to prevent the upward movement of fish from Lake Albert, and must involve a detour of several miles through dense forest for crocodiles.

This barrier to crocodiles is slender indeed, and were a few crocodiles to find a way round there is no doubt that breeding would be rapid and Lakes Edward and George would quickly become reinfested. The rapids are now in a densely forested closed area for sleeping sickness, but were human beings to reinhabit the area, such a thing as a forest clearing along the river banks to rid the country of tsetse fly might do irreparable harm to the fisheries and amenities of Lakes Edward and George by making a path for crocodiles.

Taking the aquatic fauna of East Africa as a whole it may be argued that not only did Lake Edward once contain the typical Nile series of fishes but that these were once widespread throughout all the other great lakes during the pluvial period. There is no doubt that at one time in the past all the important rivers of Africa—the Nile, Congo, Niger, etc.—contained the same fish fauna, for now each of these rivers contains the same genera of fishes although the species are, as a rule, distinct. The hypothesis was originally put forward by Günther that all these rivers had a common source in a great swamp or lake which acted as a central breeding ground on the top of the African continent. Later, when subsidence occurred in the centre of the continent, it was supposed that this lake was cut off and each river was isolated, so that the separate faunas evolved each in its own way. Later still earth movement, volcanic activity, and changes of climate occurred until the drainage systems eventually assumed their present complicated form.

I will attempt to show how this hypothesis and the mass of evidence concerning the lake faunas which we have accumulated will fit in with recent advances in geological knowledge. During the last ten years much valuable evidence concerning the previous systems of drainage in central Africa has been brought to light by the Uganda Geological Survey, which has been admirably summarized by E. J. Wayland, Director of the survey.* In general the sequence of events was as follows: previous to rift formation (Cretaceous or very early Tertiary) the Nile did not find its source in Lake Victoria and Lake Edward, but there were a series of east-to-west draining systems over Uganda. These east-to-west rivers still persist: the Kafu, Katanga, Ruizi, and

*'Summary of Progress of the Geological Survey of Uganda, 1919–1929,' Entebbe, 1931, and *G.J.*, vol. 75, 1930, p. 381.

Kagera, though their direction of flow has been reversed. Originally they found their origin in the high land to the east of Lake Victoria and flowed due west into the Atlantic *via* the Congo. Next, in late Oligocene times earth movements took place, causing rifting and the sinking of the Victoria basin, upsetting the original drainage systems.

There followed on this (in Plio-Pleistocene) the first pluvial period when the great rivers were put into direct communication, and (as I maintain) the aquatic faunas were completely intermingled. Then followed the event of supreme importance in so far as the fauna is concerned—wholesale desiccation. This was the time when crocodiles and fishes were exterminated from Lake Edward, and, as seems inevitable, Lake Victoria also dried up to a few mud-pools. As already mentioned the present fauna of Lake Victoria is peculiar, having a very large number of species belonging to a few genera. Almost all of these species are endemic (found nowhere else), whereas the Nile perch, Tiger fish, and a dozen or more other genera, very important in the Nile, Niger, Congo, and other rivers, are absent. These fishes must have existed in Victoria and Kioga during the first pluvial period, and must have been exterminated by desiccation during the inter-pluvial arid period.

After the great drought, the second Pluvial period refilled the lake basins, but since that time the Lower Nile fauna has been prevented from re-populating Lake Victoria by the Murchison Falls, and Lake Edward by the Semliki falls. The few surviving fishes and others which succeeded in entering the lakes from the nearby drainage systems found themselves in great lakes with abundant food supply, and so lost no time in evolving into the present unique faunas. It is a significant fact that among the very few fishes now living in Lakes Victoria and Edward which are also found in Lake Albert and the Lower Nile, are the well-known Lung-fish and the Cat-fish (*Clarias*), both of which are capable of living dried up in mud pools for long periods.

It is possible that during the arid period Lake Albert also dried up, as evidenced by the Kaiso bone beds, but in the case of Lake Albert there was no barrier to re-population since the Nile flows from Lake Albert to the delta without a waterfall. The fossils of Kaiso age collected by Fuchs provide definite evidence for this hypothesis in the case of Lake Edward, but in the case of Lake Victoria fossil evidence has yet to be discovered. There are fossiliferous beds near the north-east corner of Victoria which were laid down during desiccation. Leakey is studying these during his present expedition, and if he unearths fossil fishes belonging to the genera *Lates*, *Hydrocyon*, etc., there will be further strong evidence in favour of the hypothesis of desiccation which I have outlined here.

Economic Value of the Lakes

Since the early explorations in East Africa when Stanley travelled by boat on the Victoria Nyanza and Sir Samuel Baker on Lake Albert, the great lakes have been used by Europeans as waterways. For many years the only means of travelling to Uganda was by steamer from Kisumu across Lake Victoria, and steamers on Lake Kioga and Lake Albert are included in the route to North Uganda and the Sudan. The recent continuation of the Kenya and Uganda railway to Kampala across the Ripon Falls bridge has cut out Lake Victoria

from the regular chain of communications, so that most of the Lake Victoria steamers are now laid up in Kisumu harbour, and the *Clement Hill*, the flagship of the fleet, has quite recently ceased her regular weekly service to Entebbe. Until railway communications are further developed however there are excellent opportunities for increasing communications on other lakes. For instance, Lakes Edward and George together with the Kazinga channel afford an excellent waterway from the heart of Uganda right into the Congo. We found that everywhere along this route there is water of at least 8 feet depth which would give ample scope for stern-wheel paddle steamers. Again in the case of Lake Rudolf steamers might ply from Abyssinia in the north for 180 miles into Kenya Colony, if such a communication should ever prove desirable.

Apart from communications the East African lakes are of great value for their fisheries. Lake Rudolf contains an enormous potential fishery which is at present quite untouched and, until communications to the lake are improved, likely to remain so. In Uganda there are other large untouched fisheries in Lakes Albert, Edward, and George, but here too there is at present an insuperable difficulty in exploiting the fisheries owing to the tsetse fly and the fact that most of the lake shores lie in closed areas for sleeping sickness.

In the Victoria Nyanza however there is a big fishery which was started at the beginning of the century. The important fish is called the Ngege or *Tilapia esculenta*, which curiously enough remained unknown to science until Graham described it as a new species at the conclusion of the Lake Victoria Fishing Survey in 1928. When netting was first introduced to the lake in 1905 enormous catches were made, but unfortunately the Ngege only frequents the in-shore waters, and after some years' netting the catches fell off very seriously, and now there seems no possibility of improving the stock. In the open deeper waters of Lake Victoria however there are numbers of small fishes (*Haplochromis*) which are at present quite untouched. If there was in the lake a large fish easily captured which would feed on these small *Haplochromis*, an enormous amount of potential food could be made available to fishermen. There is in Lake Albert and Lake Rudolf just such a fish, the great Nile perch. Consequently it has been suggested from time to time that the Nile perch should be introduced to Lake Victoria, but it had to be strongly recommended by Graham* and Worthington† that the introduction of Nile perch to Lake Victoria should not be effected until exhaustive research has been carried out into its probable consequences, for the Nile perch might eat up the Ngege and so ruin the present fishery.

There seemed no possibility of carrying out the necessary research until a few months ago, when we made a survey of lake Nabugabo, a small area of water of about 12 square miles at the north-east corner of Lake Victoria, near Masaka. Nabugabo was once part of the great lake but has been cut off from it by the growth of a sand-spit from the Budu coast, and now is completely separated by a mile or so of dry land and swamp. It has a varied shore-line of sandy beaches, rocks, and swamp, and it contains a complete sample of the Lake Victoria fauna: in fact, it represents the great lake in miniature. All that is necessary therefore to test the effect of Nile perch on the fisheries of Lake

*'The Victoria Nyanza and its Fisheries.' Crown Agents, 1929.

†'Report on the Fishing Survey of Lakes Albert and Kioga.' Crown Agents, 1929

Victoria is to introduce the perch from Lake Albert to lake Nabugabo, and nature will do the rest. After the Nile perch have been introduced to lake Nabugabo a year or so should be sufficient to tell whether or not they will establish themselves. If they do so, one of two things must happen—either they will multiply enormously and eventually eat out their food supply and so die out themselves, or they will strike a natural balance with the other fishes and an economic fishery for Nile perch will be established. If the former, some twenty native fishermen will be thrown out of work and could easily move their activities to the nearby shore of Lake Victoria; if the latter, the introduction of Nile perch to Lake Victoria itself may well be reconsidered.

Another interesting experiment on introducing fishes has been carried out in Kenya in the case of lake Naivasha. Previous to 1925 there were no indigenous fishes in that lake except *Haplochilus antinorii*, a minnow-like fish of no value. In that year however Captain R. E. Dent, Fish Warden in Kenya, introduced *Tilapia nigra*, a fish similar to the Ngege of Lake Victoria, and after three years this fish had multiplied so enormously that great numbers could be netted anywhere along the lake shores. But Dent's ultimate object as a member of the Kenya Game Department was not to utilize lake Naivasha primarily to provide food, but to save the harassed great game animals of Kenya by attracting the sportsman to forsake the rifle for the rod.

The lake lies at over 6000 feet in the middle of the settled area of Kenya. Ever since European settlement was started in Kenya it has been much visited for its fine scenery and duck shooting, and it was generally considered that the presence of a good sporting fish in the lake would greatly improve the amenities of the Colony. Therefore Dent introduced Black Bass, a native of America, which has already been naturalized in parts of Europe, in order to feed upon the *Tilapia* and give sport to Kenya anglers. The Black Bass have now been in the lake nearly three years, have flourished and bred, and in October 1931 the lake was opened up to fishermen. As a result the price of land bordering the lake has jumped from 10*s*. to £10 or £20 per acre; hotels and other buildings are being erected, and trade in the neighbourhood has improved enormously.

Another lake studied during the last year is lake Bunyoni in the Kigezi district of Uganda. This lake also has a healthy climate at 6400 feet. It was formed in comparatively recent times by a lava flow at Mukko at the north-west end. The effect of the lava flow was to drown two of the steep-sided Kigezi valleys, and consequently the lake is now one of the beauty spots of East Africa with shores rising abruptly from clear water, and fringed by a profusion of blue and pink water-lilies.

It has frequently been suggested that lake Bunyoni could be converted into an admirable holiday resort by the introduction of a good eating and sporting fish, and since 1919 various District Commissioners stationed at Kabali, some 5 miles from the lake, have tried to effect introductions, but with little or no success. There seems here an admirable opportunity for Uganda to follow the example of the Kenya Game Department in the case of Naivasha, and consequently we have recommended that *Tilapia nigra* should be introduced to the lake, and if after a year or so these fishes are found to have reproduced satisfactorily, the Black Bass may well be introduced to feed upon them.

These are examples of what have been done and what might be done to

develop the fresh waters of East Africa, but if the whole question of farming the waters were to be studied thoroughly and scientifically many other improvements might well be effected. In making such changes however one must not lose sight of the principle that the fauna of the world as a whole should be left untouched in so far as is compatible with the progress of civilization, for introductions, if effected rashly and without full insight into their probable effects, may result in a hopeless upsetting of the balance of nature and even in the extermination of organisms invaluable to the science of Zoology. Above all, such work on changing our fauna should be done under thorough supervision by competent scientists, and before fishes are introduced to waters which they do not naturally inhabit, thorough collections should be made and the ecology should be studied in detail. For this reason it is very fortunate that the Cambridge Expedition has been able to study so many of the East African lakes before the inevitable work of developing them has progressed any further.

In conclusion I should like to offer thanks on behalf of the Expedition to those people in this country who made the work possible in the first place, and to the many others in East Africa who helped it on its way.

The following table includes all those lakes in East Africa which we have studied so far. It will serve to record a good deal of information which it has not been possible to include in the text of the paper.

The second column gives approximate area in square miles; the third the greatest depth in metres; the fourth the surface temperature in degrees Centigrade; the fifth the alkalinity; and the sixth the hydrogen ion concentration (*pH*). The significance of these last two columns is discussed in a note following the table.

Fauna of Lower Nile type:						
Albert	1640 sq. miles	48 m.	27° to 28°		0·009	9·0 to 9·5
Rudolf	3300	73	28	31	0·020	9·4 9·5
Fauna of Victoria type:						
Victoria	26,000	80	23	26	0·001	8·0 8·5
Kioga	664*	5·7	25	26	0·001	7·2 7·5
Nabugabo ..	11*	4·6	25	26	0·000	6·5 7·5
Nakavali	10*	2·9	25	26	0·002	8·0
Kachira	14*	4·1	24	26	0·002	8·0
Kijanebalola ..	27*	4·7	24	26	0·003	8·3
Edward	700	117	24	26	0·010	8·7 8·9
George	104*	6	24	27	0·002	9·3 9·8
Baringo	50	7·5	23	28	0·006	8·5 8·6
Few indigenous fish:						
Naivasha	70	20	20	24	0·003	8·3 8·5
Bunyoni	22*	40	18	20	0·002	7·6 8·0
No fish:						
Elmenteita ..	10	1·9			0·220	
Nakuru	15	2·8			0·186	
Hannington ..	18				0·160	

Note:—The *alkalinity* of the fifth column is expressed as normality correct to three places of decimals. It indicates the amount of carbonates and bicarbonates in solution. Alkalinity has a considerable effect on the type of flora and fauna,

*From 'Uganda Survey Department Annual Report for 1930.' Entebbe, 1931.

and so is useful in the general classification of lakes. To give an indication of what the figures mean, an English water supply drawn from granite may have as low an alkalinity as 0·0001 normal, or drawn from chalk regions it is about 0·004. In the case of the East African lakes, where sodium carbonate, not chalk, is the chief alkaline salt, an alkaline reserve of about 0·01 (Albert and Edward) tastes unpleasant to some people; all agree that Rudolf water, 0·02 normal, is very unpleasant to drink; while the water of the last three lakes in the table is strong enough to cause irritation to the skin.

pH or *hydrogen ion concentration* of the last column is very widely used in many branches of science but is not always understood. Its variation has great effect on animals and plants in the water. At the neutral point, as in pure distilled water, the concentration of hydrogen ions is 10^{-7}. For convenience this is expressed merely by the figure 7·0, which is called the *pH*. It follows that in acid water, where the concentration of hydrogen ions is greater, the figure representing *pH* is less than 7·0, and conversely in alkaline water the figure is more than 7·0.

DISCUSSION

Before the paper the PRESIDENT (Admiral Sir WILLIAM GOODENOUGH) said: From the high mountains of the Karakoram, of which we heard a fortnight ago, we move this evening to the lakes of East Africa—not that they are low, for many of them lie at heights from 3000 to 5000 feet—two groups of lakes, Lake Rudolf standing almost by itself, and Lakes Albert and Edward and the others farther to the south and to the west. We are fortunate in having Dr. Worthington to tell us of them, for many will remember the admirable researches he made and the description of them which he gave us some year or two ago in the Aeolian Hall. Dr. Worthington was at Rugby, at Caius College, Cambridge, where he got a First in Science with particular intention towards zoology. He gave us a description of his first expedition in 1927–28 in the lecture to which I have already referred. In 1930 he was elected to the Balfour Studentship. This enabled him to carry out the expedition that he will tell us of to-night, and we were glad to be able, in such small way as we can, to assist him financially in his undertaking. Of that expedition he will tell us in a lecture which I will now invite him to deliver.

Dr. Worthington then read the paper printed above, and a discussion followed.

The PRESIDENT: We are fortunate in having with us to-night Mr. Northcote, who was District Officer in Kenya and knows very well the part of Kenya about which we have heard.

Mr. G. A. S. NORTHCOTE: I feel great diffidence in speaking because before I arrived here I had no idea that your President would call upon me. Therefore I am afraid my remarks will be somewhat superficial. If I have any excuse for speaking it is perhaps that a long way back I was a distinct link in that chain of causation which brought Dr. Worthington out to Africa and therefore ultimately led to his giving us his very interesting lecture. The fact of the matter is that about six years ago in Nairobi, where I lived comfortably—certainly not in such surroundings as have been depicted to-night—we heard a dreadful rumour that our breakfast tables were in danger of being deprived of their daily fish, which was principally derived from Lake Victoria. I had the honour, or audacity, then to suggest—money was easier to get in those days—that we might have an expert out to see if our breakfast tables could be maintained. As a result, Mr. M. Graham, of the Ministry of Agriculture and Fisheries, and Dr. Worthington came out on that task, which led to the surveys of the lakes of which we have heard to-night. I am sure you will all agree that those surveys have added immensely to the sum of our knowledge.

Thinking of Africa, one is apt to have in mind some little bit of the continent only, but scientists such as Dr. Worthington and his colleagues are gradually enabling us to realize Africa as a single entity. Dr. Worthington's account of his party's wanderings and studies, of a few months in most uncomfortable circumstances, showed the lakes and rivers of Uganda, the Sudan, and Kenya as closely inter-related parts of a single whole; and one can only hope that other scientists are following Dr. Worthington and Dr. Leakey along other than zoological, biological, and anthropological lines so as further to complete the picture of Africa as one entity and in relation to the rest of the world.

I am afraid I am unable to add very much to the knowledge that Dr. Worthington has presented to-night. There are certain parts of the picture on which he has scarcely touched. For instance, we have to draw on our imagination—and it is not very difficult to do so—to realize the immense care, trouble, and devotion given to the organization of this very successful expedition. One or two transportation difficulties and incidents have been humorously mentioned; otherwise one might almost imagine that Dr. Worthington and his party had had a magic carpet which carried them to Turkana and on to the less-known parts of Uganda, instead of their having to travel over hundreds of miles of hot desert and difficult and perilous country. He has told us that the Turkana, whom we saw dancing, have "almost abandoned" the habit of sneaking up to the camp at night and sticking some porter or other in order to qualify for the local warrior society. One is glad of that. What he did not mention is that there is still, unless matters have greatly changed recently, very considerable risk that a party of Abyssinian brigands or Morelli will come down and raid a camp such as Dr. Worthington's party had on the shore of Lake Rudolf; and that would have been the end of the party. Abyssinia, as perhaps is well known in this hall, puts forward an entirely baseless claim to ownership of a good part of Turkana, and although the Abyssinian Government does not in any way countenance such a thing, there is no doubt that the local barons like to enforce that claim occasionally by making raids into British territory and scuppering any living thing that comes in their way. That is a live and possible danger which Dr. Worthington and his party had to face, and I have no doubt faced with the same courage and devotion which carried them through all their journey.

Captain R. E. DENT (Fish Warden, Kenya): The lecture we have heard to-night has been most absorbingly interesting to us all, particularly to myself, for I have had a good deal to do with the introduction of fish and the improvement of fishing in the Colony, doing generally what I can to help either the native or the white fisherman. In the case of lake Naivasha there has already been a certain amount of argument as to whether I should have introduced black bass; a number maintain that I should not have done so. However, since Dr. Worthington has carried out a good many investigations of other lakes and has recommended that lake Bunyoni should be treated in the same way as I treated Naivasha I feel somewhat happier than before. I think you will agree with me that we have had a most interesting lecture, and I conclude by thanking Dr. Worthington for the enjoyment he has given me.

The PRESIDENT: I call next upon Mr. Hobley. We all know what a great knowledge he has of East Africa.

Mr. C. W. HOBLEY: It is an unexpected pleasure to be called upon to pay a tribute to the work done by Dr. Worthington, work in which I have had great interest since he gave us his first lecture here. His researches and those of the team of workers who assisted him have been a memorable feature in the exploration of East Africa; a notable contribution to scientific knowledge which will also probably prove of economic importance to the country. The lecture

carried me back to many voyages I have made in a small boat on Lake Victoria, often tossed about in a storm or camping for the night on the islands in the northern part of the lake. I also much enjoyed the little vignettes of the charming crater lakes at the foot of Ruwenzori, which brought back memories of others in various parts of the country. The crater lakes of East Africa must be seen to be believed, for they are one of the most charming features of the country.

I should like to take this opportunity of asking Dr. Worthington one or two questions. Many years ago, about 1902, it was my good fortune, in company with the Magistrate at Kisurnu (Mr. A. Vincent), to come upon what I may call an extraordinary efflorescence, though it is not a strictly scientific expression; myriads of small freshwater medusae suddenly appeared on Lake Victoria. They were called *Limnocnida tanganicae* var. *victoriae* (*Proc. Zool. Soc.*, 1907, p. 643). I sent specimens to Sir Charles Eliot, who was a great authority on such things, and he sent them off to Sir Ray Lankester, then Director of the British Museum, who said they must have come from lake Tanganyika because they had been discovered there by Mr. J. S. Moore. But we would not have it, and it was then suggested that they must have been carried by birds. Well, if that was so, the birds must have been very busy. Curiously enough, within a fortnight they entirely disappeared, and as far as I know they were not seen in the lake again for about twenty years. A few years ago however they were reported by the commander of a lake steamer as having appeared again. I should like to know where they went in the meantime. Are they like the flies? What is their method of reproduction? I was asked to find answers to all those questions, but failed to do so. I feel sure that Dr. Worthington can tell us all about it.

The discovery was made some years ago near Karungu, on Lake Victoria, of some fossil-bearing beds which were declared to be Lower Miocene, and amongst the fossils were the teeth of one of the ancestors of the elephant called Dinotherium. Now Commander Bottego, an Italian explorer, some twenty-five years ago went through from Somaliland to the Nile. I think that he was killed on the way, but his expedition explored some beds near the north end of Lake Rudolf and there obtained a number of fossils. Among them it was stated that they too had found Dinotherium remains. I was very interested in this because I was connected with the discovery of the Dinotherium near Karungu, and have always wondered whether these beds at the north of Rudolf were of similar age. Count Bourg de Bozas, about 1903 ('Mission Scientifique du Bourg de Bozas,' Rudwal, Paris, 1906, p. 301), passed Lake Rudolf, and Dr. Brumpt, the medical member of his expedition, collected some fossils on the plain east of Mount Nakua and between there and the Omo river which runs into Lake Rudolf. I do not know whether these have ever been described, but it would be of interest to know what they were. I think also an officer of the K.A.R. collected in the same area some bones which are now in the South Kensington Museum. I examined these but could not find anything among them, except the vertebrae of the great Nile perch. Dr. Leakey and Mr. Hopwood have recently discovered Dinotherium remains in deposits in Tanganyika Territory classed as of Pleistocene age. It is intriguing and technically strange that what may perhaps be described as an aberrant from the main stem of the Proboscidae should have survived from the Miocene to the Pleistocene. The determination of the geological age of the Dinotherium was based on a series of discoveries from parts of Germany, the Rhone valley, and the foothills of North India; so there is, palaeontologically, no possibility that there may have been any mis-diagnosis with regard to its age. Now we are told it survived some five or six million years and is found in the Pleistocene beds in Tanganyika; it is thus of great importance to verify Bottego's discovery north of Rudolf and ascertain the age of the beds

in which it occurs, for it will give us valuable information in regard to the date of the formation of the great lake and the rift valley in which it lies. I do not know whether Dr. Worthington has any information on this question, but I am aware that he was unable to visit the north end of the lake.

The shape of the floor of Lake Rudolf is also very interesting, because I noted in the paper that the precipitous cliffs were on the east side, which agrees with the general features of the lakes in the eastern Rift Valley: the steep shores are generally near the eastern shores of the lakes to the south of Rudolf, or very little removed from them. That shows that the more recent faulting was on the eastern side of the Rift. On the western shores the ground as a rule is flat and then ascends more gradually. It has a more mature shape. The fact that the precipitous shore is on the east side of Lake Rudolf shows that the structure of this lake basin is in conformity with the other lakes in this branch of the rift and should help in an explanation of its tectonics. Dr. Worthington has given an example from Uganda where there is a steep escarpment on the western side of a lake, so the conditions there, in the western rift, are evidently different.

These are a few of the problems which occur to me. I do not expect Dr. Worthington at this hour to be prepared to give a full reply. At the same time they may help to indicate that the lakes are full of most interesting problems, and I should like to see Dr. Worthington go back and continue his wonderful researches in that region.

The PRESIDENT: Dr. Worthington has been subjected to a pretty severe examination, but I think he is ready to answer all the questions.

Dr. WORTHINGTON: The answers, I fear, are not ready, but I should like to add a word or two. In the first place, thank you, Sir and gentlemen, for your kind remarks, but I should mention that when you speak of "Dr. Worthington" it applies to the whole expedition, because I stand here not as a person but as representing the expedition in all its work.

With regard to Mr. Northcote's suggestions that we might have been eaten by the Morelli, I do not think there was much likelihood of that. If a Morelli raid was expected the authorities in charge would certainly not have let a white woman go up into the region. It is true we were not allowed to go to the northern part of Lake Rudolf, but Mr. Beadle went there alone for a short spell and so was able to look at the north end of the lake.

As to Mr. Hobley's interesting catechism, in the first place he asked about *Limnocnida;* I would like to have asked him the same question. It is, in fact, one of the unsolved problems of zoology. Many people when they heard I was going out to the East African lakes asked me to look for this little medusa. We spent six months on Lake Victoria previously and never saw it, in fact, it is an absolute mystery where the *Limnocnida* goes when it is not "in flower."

The Karungu bed question is very interesting. I cannot speak as a geologist, but I know that the dating of those beds has been changed and re-changed. For instance, the Kaiso beds of Lake Albert were originally called Pliocene; now they are Middle Pleistocene. It is certainly a very big jump from Miocene to Pleistocene, but the whole question is in a state of flux. I cannot help thinking that errors in the early classifications have been responsible for a great deal of misunderstanding. While speaking of geology it is worth mentioning that among fossils which we have collected from the bone beds of Lake Edward there is a complete skull of *Stegodon*, an extinct elephant-like creature which was supposed to be confined to Asia.

The PRESIDENT: One thing is certain, that I am representing the feelings of every person here to-night when I congratulate you most warmly, Dr. Worthington, not only on the expedition of which you were the leader—and we in this

Society know well that the leader of an expedition stands on an entirely different plane to that of any other member of it—but also on the delightful and charming evening that you have given us. What astonishes me, and it may others too, is that only fifty years have passed since Lake Rudolf was discovered; only sixty years since Lake Edward was discovered, and here we find every kind of science being carried on, developed in that very short time. It is of great interest, for instance, that it should occur to anybody that by blowing up certain rocks what is now a great lake might perhaps be made into a productive area where people, whether of the country itself or of any other country, can go and live. Then we have heard of a small lake, the shores of which are likely to be turned into a holiday resort. For what reason? So that the people can go and fish there instead of killing animals in other parts of the country.

Take the supply of salt, for instance. It is not so long ago since Mr. Kingdon Ward gave us his lecture on Asia. He said then, and repeats in his book, that what moves the whole human race in that part of the world is whether there is a proper supply of salt or not; and here we find in Africa really much the same thing.

There is one other person whom we welcome here to-night, and that is Dr. Worthington's constant companion for the past year or two, Mrs. Worthington. We would like to congratulate her on the admirable work she did in surveying and the help she gave to the leader of the expedition. Indeed, she gave up a great deal in order to join the expedition. She tells me that she had to make the choice between taking her degree at Cambridge and going to East Africa; she chose East Africa. I do not know whether honorary degrees are given, but at any rate we may say that she is qualified.

Will you please, Dr. Worthington, accept from us, with great sincerity, our whole-hearted admiration for the work which you have done, and for the admirable way in which you have displayed the results of your work. I can only hope that you may find time to put them into book form, for that would be of great interest to all those who enjoy that class of work. We thank you very much.

Professor J. STANLEY GARDINER, *who was unable to be present at the meeting, sends the following contribution to the discussion:* The whole question of the distribution of animals in these lakes, mixed up with their past history and the potentialities of the distribution of freshwater animals and plants, is of great biogeographical interest. Many of the living organisms of the water are of great importance scientifically, and these lakes are the centres of much bird life and the rallying points for some mammals. There are nine quite considerable lakes in Kenya, a like number in Uganda, and four in Tanganyika. There are proposals for the introduction of fish into most of them; possibly North American fish, for sport or food. The food question for immense lakes carrying large populations on their shores is most important, but there are many of these lakes in little-populated areas, some in fly belts with no populations around them. There could be no possible hurt if selected lakes were declared as "Nature Reserves" to be left entirely as they are, because they can always, if necessity demands this course, be opened up later. Meanwhile those lakes and areas could undoubtedly be studied to our profit.

Mr. Graham, Dr. Worthington, and Miss Jenkin, in three expeditions, have now given us an account of all the lakes of Kenya and Uganda except Jipe. Tanganyika has not been investigated to the same scientific level, and the other three lakes of this territory (Natron, Eyasi, and Rukwa) are unknown. Tanganyika is profoundly different from these northern lakes on account of its great depth, and an investigation of the bottom conditions and fauna is most desirable.

THE LÖTSCHENTAL: A REGIONAL STUDY: *A paper read at the Afternoon Meeting of the Society on 18 January 1932, by*

J. F. UNSTEAD

THE essential characteristic of the regional method in geography is to take as the units of study definite areas of the Earth's surface; it regards these as wholes, and examines the way in which their physical and human elements are inter-related and the influence of the unit-areas upon one another. From this point of view the writer considered the part of the Alps in which he was spending a vacation and put to himself the questions: Into what unit-areas can this part of the earth's surface be divided, and how may their characteristic features be stated and explained?

The primary division would obviously be into valleys and highland areas, and the valley type was selected for study as being the more accessible and offering many examples of that synthesis of the living and non-living factors which is the special object of the science of geography. The consideration was then limited to a single valley, since even that area is not uniform, and an examination of its features provides an opportunity of attempting an answer to the question: What are the smallest units with which geography must deal?

Experience has suggested to the writer that the best method of presentation is one which is apparently descriptive but at the same time brings out those geographical elements (*e.g.* structure, relief, vegetation, and human activities) which mutually interact and thus may be regarded as causal factors.*

The main object of this paper is therefore to examine the nature of the selected valley, the Lötschental, and of its constituent unit-areas, and at the close to indicate briefly the extent to which the Lötschental may be regarded as typical of a valley of this part of the Alps.

The Lötschental is the valley of the Lonza, a small right-bank tributary of the upper Rhone joining the river below Brig. The main part of the valley extends in a south-westerly direction, parallel to that of the Rhone, for about 17 km.,† but the Lonza turns sharply southward for about 8 km. to join the Rhone valley. The greater part of the Lötschental thus conforms to the general longitudinal direction of this region of the Alps and is characteristically wider than the lower section which is transverse and much narrower.

As the greater part of the valley is enclosed by glaciers and snowfields through which project peaks rising to between 3000 and 4000 m., while in the lower part the Lonza has cut a narrow precipitous gorge where it turns to meet the Rhone, the valley is extraordinarily isolated by nature. It has been brought

*It will be observed that no attempt has been made to investigate the origins of the phenomena of any category: that is regarded as the work of the particular scientists and not the business of the geographer. The study of the evolution of each of the phenomena —*e.g.* the land-forms, the plant coverings, or the economic systems—needs a special training and must be left to a specialist.

†To facilitate reference to the Swiss maps, the metric system is used; the greater part of the valley is excellently shown upon Sheet 492 (Kippel) of the Topographischer Atlas der Schweiz, scale 1 : 50,000, and the lowest portion with the adjoining Rhone valley on Sheet 496 (Visp).

into easy communication with the outside world only by the great engineering feat of the construction of the Lötschberg railway connecting the Swiss plateau with the Rhone valley. This line, opened in 1913, pierces the Lötschberg, the north-west bastion of the valley, by a tunnel about 15 km. long, reaching the Lötschental, where it turns from its longitudinal to its transverse direction; thence it can utilize the lower portion only by a series of tunnels and embankments with works necessary to protect the line in winter from snow drifts and avalanches. The station at the southern end of the tunnel gives access to the valley at Goppenstein (altitude 1194 m.), whence a road leads up as far as the village of Kippel; beyond that point mule-tracks are the only means of communication.

The demarcation of a geographical region should conform to two principles. In the first place it should separate areas of distinctive characters; in the second place, since the ultimate object of the study is to show the inter-relations of the various geographical factors in building up the whole "complex," the demarcation should enable the mutual workings of these factors to be most clearly perceived. For these reasons the boundary of the Lötschental is in general drawn along the upper limit of vegetation. Outside this limit are the snowfields and heights of bare rock; within it the ground is usually covered in the highest parts by scanty herbage and grass, below that forest or cleared alpine pastures, and along the valley bottom meadows and small patches of cultivation.*

For the sake of comparison with other valleys, it may be noted that the upper limit is about 2600 m., while in general the boundary on the sunny north-western slope is about 200 m. higher than that of the shady south-eastern side. At the head of the valley the Langgletscher has thrust itself downward between the valley walls so that here the limit of the valley is as low as 2000 m.

In the lower transverse section of the Lötschental the boundary of the valley is taken along a line which is approximately the watershed between the Lonza and the smaller tributaries of the Rhone.

By this demarcation the valley has a width of about 3 km. in its upper part, increasing near the end of the longitudinal portion to about 5 km., and an area of about 84 sq. km.

The Lötschental has been carved from the mass of crystalline rocks of which this portion of the Alps is composed, and its present form is due to the exposure of a band of schists between two masses of granite, as is shown by the sketch-section through the upper valley (Fig. 1). The schists have been worn more deeply than the more resistant granite. A narrow band of limestone separates the northern granitic mass from the lower schistose strata. Throughout its longitudinal portion the south-eastern slope is steeper and narrower than the north-western slope; this asymmetric form is conformable with, and probably due to, the dip of the schists to the south-east.

At the lower end of the longitudinal section the drainage is in the reverse direction, *i.e.* from south-west to north-east, and here the tributaries, Faldumbach, Dornbach, and Ferdenbach, have cut small, high-lying valleys in the schists; the upper ends of these valleys are surmounted by a series of peaks,

*On the 1 : 50,000 map the contours within the valley as thus defined are shown in brown; those outside the valley by black on bare rock and by blue on permanent snow and ice.

making a striking skyline as one looks down the Lötschental. These peaks are the Faldum Rothorn, the Resti Rothorn, and the Ferden Rothorn; they are formed of highly contorted sedimentary strata, mainly resistant sandstones, whose red colour is due to iron compounds in the rocks. Where in its lowest course the Lonza has had to cut through the south-eastern granitic barrier, the valley narrows and finally becomes merely a gorge.*

The valley has been in the main carved out by river action and weathering. The impermeable nature of the rocks and the steep slopes cause a rapid run-off of the abundant rain and snow-water and a correspondingly rapid cutting of the main valley, the furrowing of its slopes, and the formation of fan-shaped screes at the valley bottom. Recent ice-action is responsible for some of the features of the uppermost part of the Lötschental, including cirques and hanging valleys. In the middle part, glaciation of the Quaternary Ice Age has affected the form of the slopes and determined the position and

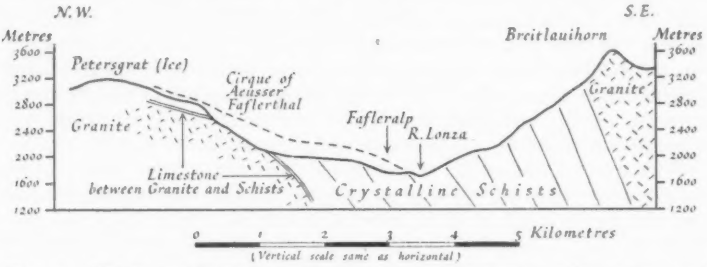


Fig. 1. Sketch-section showing structure of Lötschental, with cirque and hanging valley of Outer Fafler stream. Broken line marks typical north-western slope of Upper Lötschental where not cut by transverse streams

character of important pastures and summer settlements. The sketch-section through the middle Lötschental at Kippel (Fig. 2) shows a decrease of slope, particularly on the north-western side, at an altitude of about 2000 m. At this level the Quaternary glacier cut into a previously existing river valley whose sides are indicated by the steeper slopes above this level. The ice scooped out a trough with a U-shaped section in which morainic material was deposited. After the retreat of the ice, river action cut another and deeper valley, V-shaped, within the older one; it has removed much of the glacial deposit but allowed, particularly on the north-western side, the retention of a considerable area with relatively gentle slope and fertile soil. Truncated spurs also give evidence of glacial action.

The combined effect of these agencies of erosion and deposition upon the rock structures has been the formation of the varied land-forms, which differ-

*Such facts about the composition and arrangement of the rocks as influence the features of the valley seem to the present writer within the province of the geographer. For geologists he adds that the Lötschental forms part of the root-area of the Helvetian Nappe, the north-western schists belonging to the lower, the south-eastern ones to the upper, series of the Nappe; also that the Rothorn strata are largely of Liassic, but in part of Triassic, date.

ing in altitude, slope, and composition, form the minor units of the area. The primary division of the Lötschental is twofold: (I) the longitudinal portion; (II) the transverse portion. A secondary division of the former gives: (A) the valley bottom; (B) the right side, or sunny northern and western slopes; (C) the left side, or shady south-eastern slope. Moreover, both the valley bottom and the northern slope of the longitudinal valley show marked differences above and below the village of Blatten.

The valley bottom of the longitudinal portion (I A) will be first considered, and the characteristics of its various geographical units examined. The Langgletscher descends south-westward from the ice-mass of the Lötschenlücke (Lötschen gap), at a height of 3200 m., where it adjoins the snowfields of the Aletsch Glaciers. It works down the hollow between towering rock ridges till the ice disappears at an elevation of 2000 m., and the Lötschental may be considered to begin. The first minor unit of the valley bottom is the outwash area.

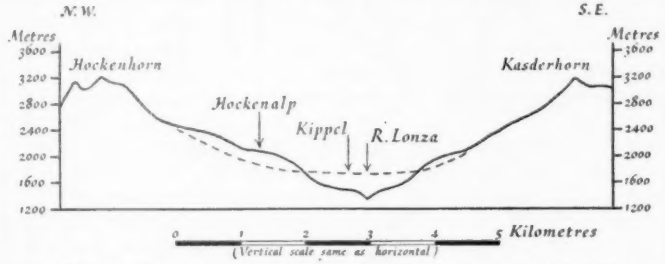


Fig. 2. Sketch-section showing typical surface form across middle Lötschental. Broken line marks trough of Ice Age glacier

Here is a fairly level space of about 1 sq. km., an almost barren expanse composed of rock material of all sizes, from huge masses of rock to fine sand, deposited in part by the melted ice-water, and in part by the ground moraine when the Langgletscher at no distant date covered this area. How recently the glacier has retreated is shown by a lateral moraine extending well beyond the present glacier snout, with its steep sides scarcely scored by subsequent erosion. The streams that emerge from the Langgletscher and from the small Distel Gletscher which descends on the south slope form a maze of water channels, many of which have constantly varying beds. On the higher patches of this area vegetation has begun to assert itself; a very scanty short herbage is here and there to be seen, there is some scrub of dwarf willow, and even small larch trees have taken root, though menaced by minor advances of the glacier which have destroyed their predecessors. Temperatures are usually lower here than at corresponding altitudes on the sides of the middle portion of the valley, owing to the down-settling cold air from the glacier—a movement which can persist the more easily as the prevailing westerly winds are normally gentle in the practically enclosed Lötschental.

Below the outwash plain is a rather larger area through which the descending Lonza has cut a gorge of increasing depth and steepness. The area is flattish, and in its centre is the Grundsee, a small lake of clear, deep water frequented by

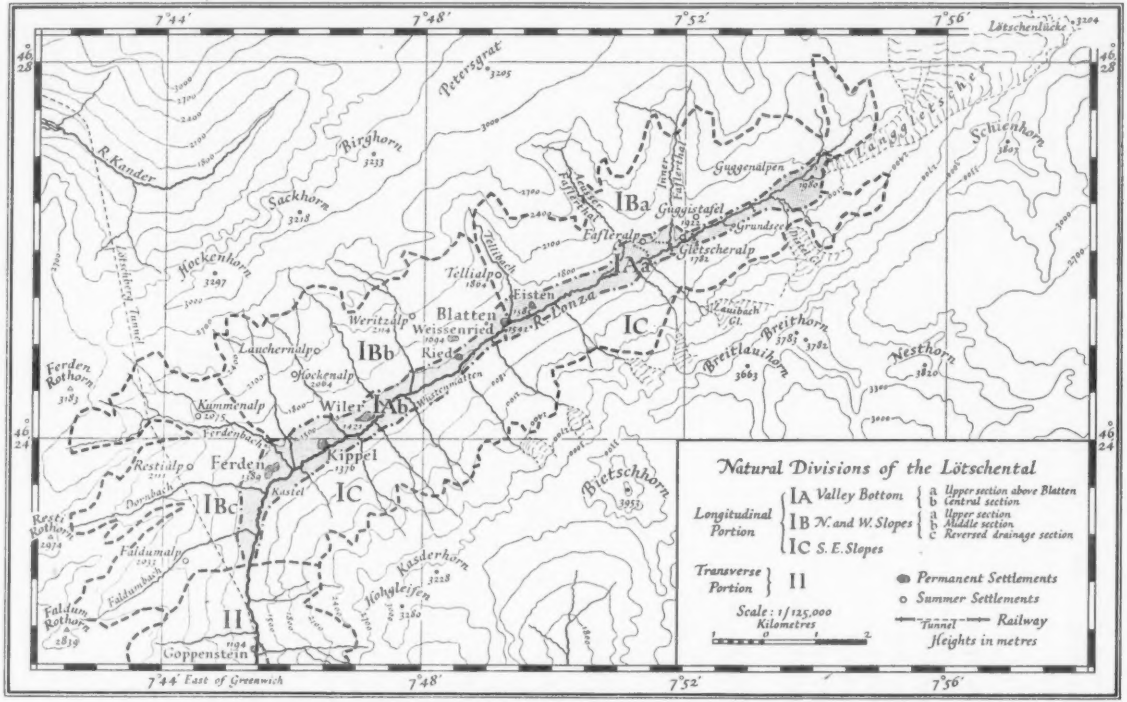

7°44′
7°48′
7°52′
7°56′
46° 28
46° 24
Lötschenlücke 3204
Petersgrat 3205
R. Kander
Birghorn 3133
Sackhorn 3218
Hockenhorn 3297
Lötschberg Tunnel
Ferden Rothorn 3183
Kummenalp 2015
Ferdenbach
Restialp 2111
Ferden 1380
Kippel 1370
Kastel
Dorfbach
Restirothorn 2974
Faldumalp 2032
Faldumbach
Faldum Rothorn 2839
Goppenstein 1194
Tellialp 1804
Tellibach
Fafleralp
Fafleralpbach
Inner Fafleralp
Gletscheralp 1782
Guggistafel 1923
Guggenalpen 1980
Grundsee
Grundbach Gl.
Laubbach Gl.
Eisten 1760
Blatten 1321
Weissenried 1094
Weritzalp 2114
Lauchernalp
Hockenalp 2084
Rieder 1783
Wiler 1423
Wetterwaldbach
R. Lonza
Tännbach
Schienhorn 3807
Breithorn 3782
Breitlauihorn 3663
Niesthorn 3820
Bietschhorn 3953
Kasderhorn 3228
Hohgleifen 3220
IBa
IAa
IC
IBb
IAb
IBc
II
Natural Divisions of the Lötschental
Longitudinal Portion
IA Valley Bottom
a Upper section above Blatten
b Central section
IB N. and W. Slopes
a Upper section
b Middle section
c Reversed drainage section
IC S. E. Slopes
Transverse Portion II
Permanent Settlements
Summer Settlements
Tunnel
Railway
Heights in metres
Scale: 1/125,000
Kilometres
0
1
2
7°44′ East of Greenwich

Fig. 3

cattle belonging to the neighbouring Gletscheralp summer settlement. These Grundsee flats have been formed by screes working down from the heights of the southern slope and covering the morainic material. The higher part is therefore largely bare; the lower part nearer the gorge is marshy pasture.

Below the gorge the Lonza bed spreads out into an old lake-bottom where the waters were once held up by the higher ground of the Fafleralp. This Gletscheralp lake-plain is the only really flat area in the whole valley; it gives a rich pasture of grass and flowering herbaceous plants, but much of the ground is still spongy though man has intervened by some attempt at cutting drainage channels. Through this plain the Lonza meanders, the main stream wandering over a wide flood-bed of boulders and gravels. The river is of course normally high in summer when the melting of the ice and snow is greatest, but its floods occur after heavy cyclonic rains lasting several days.

Here is the first of the many plank-bridges across the stream, giving access from the Grundsee flats to the summer settlement at the Gletscheralp (altitude 1782 m.). This settlement consists of some score of small chalets; stone is used for the foundation, but the rest of the building is of larch planks which in the course of years gradually mellow to a characteristic dark brown. The shingle roof has no chimney, yet under it are the dwellings of the workers as well as cowsheds and barns.

As soon as the advance of spring allows, there is a preliminary cleaning-up of the settlement and the necessary repair of watering-places, paths, and enclosures, work carried out in common by the peasants using the alp. At the beginning of July the annual migration of people, cattle, sheep, and goats is inaugurated by a fête day, and while during the summer the hay-cutting on the richer meadows and its storage in the barns occupy the stronger members of the families, the older women and younger children drive the cattle daily to and from the high pastures where they feed on the poorer herbage. The cattle on the Alps are commonly in herds of about a hundred, belonging to the members of each settlement; there are also large numbers of horned, black-and-white, long-fleeced mountain sheep, a smaller number of goats and relatively few pigs. Each evening the cows are milked in the manure-surrounded sheds, and cheese is made to be taken down to the villages of the middle section of the valley at the end of the season. Towards the latter part of the summer the stronger members of the families go down to their villages for the harvests there, and the rest remain till early September, when they drive the cattle down and the children begin school. But in early December, when the work in the lower valley is over, the cattle are brought up again for two or three weeks, that they may live in the sheds and finish the hay stored in the barns; it is easier to drive the cattle up a second time than to take the hay down the valley. In the upper Lötschental snow covers the ground from about the beginning or middle of November and remains till about the middle or end of May; thus the winter, considered from this point of view, normally lasts more than five months, but from year to year this period varies by as much as a fortnight at either end.

Each alp is occupied by an association of households, largely but not necessarily belonging to the same commune in the middle part of the valley. Each member has the right to take up a certain number of animals, and a relatively prosperous man may have his cattle on several alps.

Below the Gletscheralp is the Fafleralp; here a bar of higher ground extends across the valley bottom, scree-formed on the left side, morainic on the right, and through this barrier the stream cuts a course obstructed by rapids. The Fafleralp bar is wooded with larch and spruce, but has been to some extent cleared for pasture around the settlement and its tarn. Here are sheep-pens into which the hundreds of sheep in the upper valley are driven in October for numbering and sale; the pens are used to grade the animals according to the value of their wool.

The pasture has been improved not only by cutting down the trees on the Fafleralp, but also by collecting the innumerable morainic stones that now stand, cairn-like, heaped up on the larger boulders in the meadows. In addition, on this higher ground small irrigation channels have been cut to bring water from the side of the valley and spread it over the pastures, but at the present time many of these channels are falling into disuse. On the highest part of the bar the Fafleralp Hotel (1795 m.), half hidden between the trees, commands magnificent views both up and down the Lötschental, and the consequent "tourist industry," though small, has some effect on this part of the valley. The varied activities make the Fafleralp seem a busy spot during the summer, but in winter the whole district is snow covered and deserted.

Below the Fafleralp and extending as far as Blatten the valley bottom is relatively level; it may be termed the Eisten Flats, from a small settlement on its border.

Eisten stands on a rock terrace above the stream at an altitude of just under 1600 m., and is the innermost permanent settlement of the valley. There are one or two houses and a small church, and by them some tiny patches of rye and potatoes, with a few ash and birdcherry trees; the little settlement stands like an outpost of human effort in this upper Lötschental.

Immediately above and below the rocky terrace of Eisten the river-bed widens; its flood plain shows a wide expanse of gravel and boulders, on either side of which is pasture, rather rough and poor above Eisten, but becoming richer as Blatten is approached.

Here the colder, relatively poor, and sometimes barren upper section of the valley bottom gives place to the warmer, richer, and populous central section. There is a significant difference in the length of the seasons, the winter being quite a month shorter in the middle than in the uppermost part of the valley. Blatten (1542 m.) is built upon the side of a marked cutting where a rocky mass extends from the northern slope of the valley and is met by a great fan-shaped scree from the southern slope; the bar thus formed accentuates the gradual change due to altitude and climate. Below it the riverside pastures are practically continuous, the grasses and herbs growing completely over the morainic rocks and the humps being discernible only by the unevenness of the meadows. Deciduous trees increasingly displace the coniferous, aspen and birdcherry become common, and ash and sycamore appear, while by the settlements cherry and apple trees yield their fruit. Cultivation, too, becomes important. Behind Blatten, for example, on the slope facing the sun, is a space of about the same extent as the village itself, covered with small garden-like patches on which are grown rye and barley, potatoes, beans, and beet. The greatest area is given to potatoes, though owing to the isolation of the valley it is little more than a

century since the plant was introduced by a returned mercenary. Rye is here on the margin of cultivation, for in some years it succeeds and in others it fails; barley, with its shorter vegetative period, is a safer crop, but is less widely grown. Rye bread and cheese are the staple foods of the people, and animals and milk products the main exports. Wine brought from vineyards in the Rhone valley owned by the richer farmers was more used in the past than at present, when coffee and beer can be imported. Cultivation was more widely spread in past days, for like most of Western Europe the valley now finds dairy farming more remunerative. A minor industry is bee-keeping, and the brightly coloured rectangular "hives" which completely cover the sunny walls of some of the houses add to the attractions of the villages.

The central section of the valley shows less variety than the upper, for the agencies of erosion and deposition are less active in this area of lower altitude and gentler slope, although the Lonza is now cutting an inner trench in the valley floor. The trench is clearly apparent by Wiler, and becomes wider and deeper by Kippel which stands well above the river. Near Kippel and Ferden this cutting allows meadow and patches of cultivation on its slopes; steep as the incline is, however, terracing like that of Mediterranean countries is not employed. Below Ferden the stream has been forced across the valley bottom by deposits from the Dornbach and Faldumbach, and therefore is close against the south-eastern slope, and here the inner trench has been cut to a deep and precipitous gorge of striking appearance, on whose sides shrubs and trees have a precarious roothold.

All the settlements of the valley are on the right bank of the Lonza; on the left are only barns joined by foot tracks. Centuries ago there were settlements, as at Kastel opposite Ferden and at Wüstenmatten nearly opposite Wiler, but rock falls and avalanches from the precipitous southern slopes destroyed them; their inhabitants migrated to the safer and sunnier northern banks, and now only groups of barns mark the position of the earlier hamlets.

Man counts for much in the landscapes of the middle valley; the meadows with almost knee-deep growth in summer look after cutting almost as smooth and green as lawns in England, barns and sheds are dotted over the whole valley bottom, and villages follow one another, at intervals of about a kilometre, along the terraces immediately above the river.

The four main villages are Blatten, Wiler, Kippel, and Ferden; they are nearly equal in size, and in them live most of the people of the Lötschental. The census returns show a growth of population from about 1000 in 1900 to 1150 in 1910 and to 1200 in 1920, after allowance has been made for the temporary increase during the construction of the Lötschberg tunnel. It thus appears that the rate of growth has diminished, and it is probable that the present population is not much more than 1200.

The human habitations, both the summer alp settlements and the villages of permanent occupation, are all of the group type, and there are no isolated farms or dwellings. The map of scale 1 : 50,000 does not distinguish between the inhabited houses and their dependent buildings, but the proportion has been roughly estimated as one of the former to three or four of the latter in the villages. There are about six persons to a house on the average. There are also summer dwellings where the Swiss map of 1 : 50,000 uses the term "alp," as

at Fafler*alp*, but the numerous other buildings shown on this map are merely barns.

Blatten is situated at the upper end of the middle section of the valley, and like most settlements on the boundary of geographical regions it has among its functions the linking of the respective populations and the interchange of their products; in this case however winter brings about a cessation of such activities. Perched upon rock ledges, the village consists of an irregular huddle of houses, cowsheds, and barns; like most of the settlements it is of the amorphous type, for there is no plan in its arrangement and the buildings are in some parts separated by spaces (one cannot call them streets) only a yard or two across.

Wiler (1421 m.) is an exception to this rule of irregular growth; it was burnt down in 1900 and has been rebuilt on a definite system, and is now of the route-line or "road-village" type. It has a wide, straight main street with others parallel to it. Dwelling-houses occupy the central area, while the cowsheds and barns lie on either side. Many of the houses have been entirely rebuilt of stone in place of wood, and many of the roofs are of slate or corrugated iron.

Kippel (1376 m.) is the centre of the region from the human point of view. It is at the "head" of wheeled transport and is the chief market-centre.

Communal life and work is a marked feature of the Lötschental; the isolation of the valley has made possible survivals from past times which, though lessened, are still remarkable. Originally the cultivated land and the meadows, as well as the rougher pastures, were held and worked in common, but family ownership is gradually developing. Communal work is still responsible for the maintenance of roads and tracks, for the cutting and transport of wood from the forests and hay from the meadows; these duties are apportioned to particular families by drawings by lot.*

The right side, or northern and western slope, of the longitudinal valley (I B), may be sub-divided into three parts, viz. the upper section above Blatten, the middle section which drains to the Lonza between Blatten and Ferden, and the western section in which the drainage is from south-west to north-east. Both the northern and the western sections have the characteristics of the "Sonnenseite" or "adret."

The northern slope above Blatten, like the valley bottom which it overlooks, is clearly articulated, being cut by four transverse streams all issuing from cirques which mark the transition from highland to valley.

Overlooking the outwash area of the Langgletscher and the Grundsee flats of the valley floor are the slopes of the Guggenalpen and the plateau of the Guggistafel. The form of this almost level terrace and the existence of huge ice-smoothed masses of rock are clear evidence of glacial influence on this landform. The deeply dissected south-western end of the Guggistafel has an abundant cover of trees, shrubs, and grass; the plateau portion is relatively bare and marks the disappearance of tree growth, although its altitude, a little under 2000 m., is lower than the tree line in the middle section of the valley, where forests climb well above the 2000-m. level. The lower temperatures adjoining the great ice-masses which surround this district are doubtless the

*For some of the facts relating to the usages of the people the writer is indebted to a study of the traditions and customs of the Lötschental made by the Rev. J. Siegen, the priest of Kippel.

cause of the difference. Here, as above the tree-level over much of the Lötschental, the place of the forest is taken by a low growth of shrub in which the whortleberry yields a valued harvest to the women and children sent out to gather the berries in August.

The Guggistafel settlement (1922 m.) is remarkable in that its occupants are not Lötschental villagers but mount each year to this most remote part of the valley from Steg and Hothen, villages of the Rhone valley at the exit of the Lonza; their ways are in some respects different from those of the Lötschental peasants and their chalets lack the carved inscriptions characteristic of the houses of the valley.

The Inner Faflertal and Aeusser Faflertal begin in cirques at the bottom of which are masses of boulders and gravel with patches of low-growing vegetation. Their valleys then narrow and exhibit the characteristic features of hanging valleys deeply notched by the out-flowing streams; in the outer Faflertal the water power is utilized for lighting the neighbouring settlement.

Between the Aeusser Faflertal and the Tellibach the slopes above the Lonza are steep and well-wooded. Here spruce are more numerous than the larches which predominate in the cooler parts, and on this slope timber is being cut in considerable amount; it is cut and stacked in summer to be taken down to the valley in winter when the boulder-strewn beds of the smaller streams are ice-covered and afford convenient tracks. The valley of the Tellibach resembles those of the Fafleralp, but between the cirque and the notched descent it is wider and gives a space for pasture on which the Tellialp settlement (1864 m.) is situated.

The middle section of the right-hand slope extends from the Tellibach to the Ferdenbach. Here there are no cirques and the streams that score the mountain side have cut no deep side-valleys, but the features are arranged more or less in zones of altitude. Below the steeper slopes that overlook the Lötschental is a more gentle descent, affording a pasture ground though boulder-strewn and interrupted by craggy outcrops. This is the glacial terrace at a height of between 1800 and 2200 m., and upon it are the summer settlements of Weritzalp, Hockenalp, and Kummenalp, just over 2000 m. Below this level the slope again steepens and in general is well-wooded, but occasionally there are flatter portions cleared for pastures. On one of these is the permanently occupied village of Weissenried, the highest habitation of the Lötschental, at an elevation of 1694 m.* The village has a church, and around it, on slopes facing the sun, are patches of cultivation. Compensation for the higher altitude is given by the longer period of insolation as compared with places in the bottom of the valley where the morning sun is hidden by the chain of the Bietschhorn and the neighbouring peaks. The pasture around Weissenried is rich; besides clearing the forest, the people have removed or stacked the boulders and have constructed a net of small irrigation channels.

The western portion of the right-hand slope is the area drained in the reverse direction, *i.e.* from south-west to north-east, by the Ferdenbach, Dornbach,

*A map entitled "Höhengrenzen menschlicher Siedlung" is given in vol. ii of the new E. von Seydlitz *Geographie*, according to which human settlement reaches nearly 2100 m. in this region. The facts given above show that this map must refer to the limit of the Alps inhabited only in summer, and not to permanent settlement.

and Faldumbach. As one looks down the main Lötschental, one is struck by the appearance of the last two of these streams, in their high, V-shaped, grassy valleys bounded by steep rock-walls and overlooked at their heads by the Rothorn peaks. At the level of about 2000 m. the streams enter the belt of forest which marks the change of incline, to rush down the post-glacial slope of the Lötschental. Here their valleys become mere notches and their direction changes, from north-east to east, and even to south-east when they have nearly reached the Lonza. Their grassy upper valleys give pasture for the summer alp settlements of Faldumalp (2033 m.) and Restialp (2111 m.); these are situated where, on the ridges between the valleys, there are small remaining portions of the glacial terrace immediately above the wooded slope.

The left or south-eastern slope (I C) of the longitudinal valley has relatively little human significance, for it is steep and is the "Schattenseite" or "ubac." It shows only gradual differences as it is followed from near the source of the Lonza to the transverse turn. In the upper part of the Lötschental, glaciers of moderate size, such as the Distel and Lauibach glaciers, have invaded the upper levels, but farther to the south-west this feature becomes much less marked. Tree growth, on the contrary, scarcely exists on the left slope near the Lonza source, a few belts of larch appearing opposite the Fafleralp, but farther along to the south-west it gradually increases in extent, and fine stands of spruce as well as of larch clothe the lower levels of the valley wall.

As on the opposite side of the Lötschental, a change of slope is seen, but on this steeper side of the valley erosion has left but small traces of a glacial terrace though striations on the rock bear witness to the work of the ice. The characteristic feature of the south-eastern slope is a land-form resembling in shape an hour-glass, where a V-shaped cutting above the change of slope meets an inverted V-shaped fan below that level. The upper V-shape is due to the erosion in the older river valley of a notch cut by two or three streams originating in small glaciers and uniting at the change of slope; the lower inverted V-shape is formed by the deposit of the debris in a fan-shaped scree in the younger river valley; thus the formation does, in fact, perform the function of an hour-glass measuring the passage of geological time. In some parts the screes have been invaded by tree growth, particularly towards the lower section of the Lötschental, but more often their vegetation is of the scrub type, willow and juniper on the drier parts and alder on the lower and wetter parts; low-growing herbage and scanty grass are also to be seen on these screes, while bare boulders and stones form considerable areas where the streams have cut their furrowed and changing courses and prevented the development of plant life.

As in other parts of the Lötschental, so on this left-hand side the change of slope occurs at about 2000 m., and in the upper part of the valley it is emphasized by a frequent coincidence with the tree-line. Timber is cut, berries are gathered, and animals are to some extent pastured on this side of the longitudinal valley, but there are no wide alpine meadows, and the sun shines upon it only during summer afternoons and evenings; hence its productivity is considerably less than that of the wider and warmer opposite slope.

Of the transverse valley (II) there is relatively little to say. Its width is much less than that of the upper and middle Lötschental, and near its mouth it narrows to about 1 km. It presents the appearance of a series of closely inter-

locking spurs, so that from no point can any considerable view of it be obtained. Glaciation is revealed by a change of slope rather than by terracing, and there are merely a few small patches of summer pasture on the western side. In general, the sides form a narrow, sharp-pointed, V-shaped cutting; where the valley floor does occasionally open out to a small, flattish area, this is overhung by precipitous and sometimes vertical rock walls. Dark woods of spruce cover much of the slopes, and into the depths the sun penetrates merely for a short time at midday. Here practically the only buildings are those connected with the railway, and the road is no more than a mule track. Avalanches constantly menace the route in winter and until the snows have melted in spring; till recently the Lötschental was frequently isolated for days or even weeks at a time, and now the railway communication may be temporarily cut.

Farther down, the river is overlooked by a rock wall rising sheer for about 500 m., and here a power station utilizes the energy of the stream for the use of the settlements of the Rhone valley. The Lonza has cut down to the level of the larger river (630 m.), and its exit shows none of the features of a hanging valley.

An examination of the Lötschental leads to the conclusion that the landforms are the primary criteria which distinguish the minor units from one another, climatic and other differences depending on altitude and slope. It is interesting to consider also a division made according to the utilization of the region by man, and on this basis three areas are to be distinguished. (i) The land occupied, and largely transformed, by permanent settlements, route-ways, cultivation, and the development of the richer pastures which may be cut for hay two or three times each year. This area may be shortly termed the "permanently occupied area"; it includes the floor of the longitudinal valley as far up as Blatten, or perhaps Eisten, and also the terrace of Weissenried. Its extent is about 8 sq. km., and its upper limit is about 1700 m. (ii) The land occupied by the summer settlements, the tracks which serve them, and the summer pastures; this "summer alp area" comprises most of the remaining part of the floor of the longitudinal valley, and the lower portions of its northern and western slopes. Its extent is about 16 sq. km., and while on the shady side of the valley it seldom rises above 1600 m., on the opposite slope it reaches over 2100 m. (iii) The land utilized only for rough grazing, some cutting of timber, and the collection of berries, small fuel and bedding for cattle; this area includes all the rest of the Lötschental—its higher, steeper, and less sunny portions. Since this "rough grazing and wooded area" extends over about 60 sq. km. it occupies the greater part of the whole valley. These three divisions are shown on Fig. 4.*

To be of value for comparative purposes, estimates of the density of population in regions such as the Alps must take account of the extent to which the areas are utilized. An estimate of so many persons per square kilometre or square mile has little significance if the highland masses are included, but

*The boundaries, even of the valley as a whole, are necessarily only approximately indicated; in some cases the limits as seen in the field are definite, but in others the areas merge imperceptibly into one another, while frequently small patches of one type appear in the main area of another. Such boundary conditions could be shown only on a large-scale map.

gains in value as an indication of the ability of the land to support human life, if the type of country included in the calculation is indicated as precisely as possible.

In the case of the Lötschental, if an estimate of the population as being 1200 persons is accepted (and the very few inhabitants of the lower valley near the railway station are excluded), there is a density of population of about 150

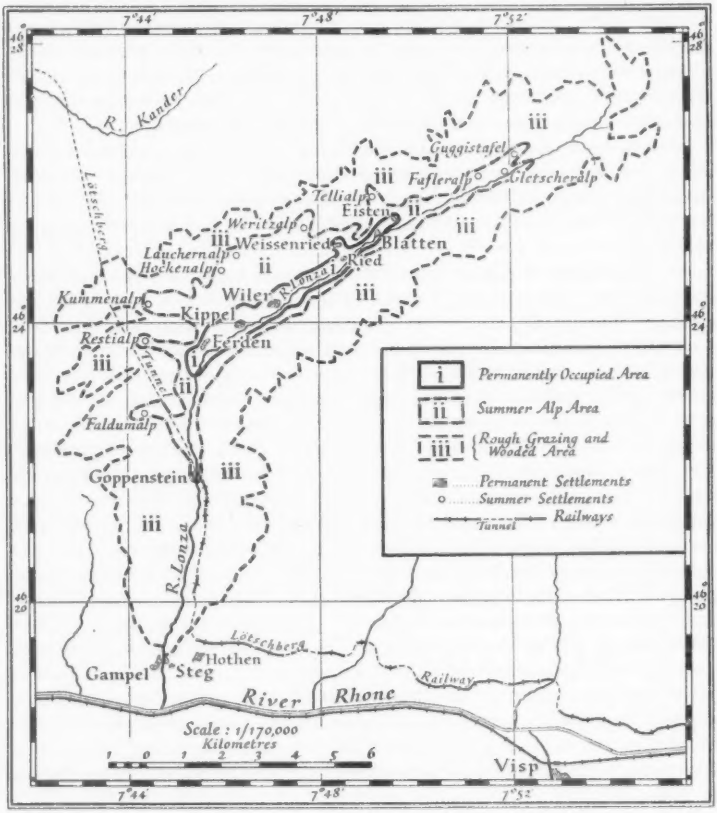


Fig. 4

persons per sq. km. (400 per sq. mile) when the permanently occupied area alone is taken as the basis of population, or about 50 persons per sq. km. (130 per sq. mile) if the combined area of permanent occupation plus summer alp is considered, or about 14 persons per sq. km. (38 per sq. mile) for the whole valley as here demarcated.

When it is remembered that the habitations in the Lötschental are definitely restricted to a small area, it is difficult to understand the principle underlying

the representation of the distribution of population on Nussbaum's map "Die Volksdichte der Schweiz." This map adopts the common system of isopleths enclosing particular densities of population, and shows an inner area in which the density is given as between 50 and 75 inhabitants per sq. km., extending by the Lonza from about Blatten not only to Ferden but the whole distance to the Rhone valley, while this area is completely surrounded as far as the Rhone valley by an outer one of density between 1 and 10 persons per sq. km.

From the preceding account of the Lötschental it will be seen that on the whole it may be taken as typical of the high-lying secondary valleys of the interior, crystalline Alps. The features which distinguish the crystalline from the limestone areas are here shown: the relative abundance of water, the almost unbroken plant-covering, the rarity of precipitous slopes, and the liberal supply of timber and pasture. Corresponding to its interior situation are the markedly high altitudes of the snow-line, the tree-line, and the upper limit of population. The altitude of the main settlements is such that the cultivation is small in amount and very restricted in character. It is also the cause of the simplicity of the annual migrations in the Lötschental as contrasted with those of the neighbouring Val d'Anniviers, where from the villages the people go upward by stages, first to the "mayen" and later to the "alpe." Moreover the isolation of the Lötschental from the Rhone valley is so much greater than that of the Val d'Anniviers that there are no spring and autumn migrations down to the main valley.

While in most respects the Lötschental may be considered typical of its area, it has certain exceptional characters. The extent to which post-glacial river action has modified the trough form of the valley is unusual; for example, this valley shows a marked contrast with that of Lauterbrunnen, its nearest neighbour to the north-east, both in the physical features of the valley-bottom and in the situation of the villages. In the Lötschental, except in its uppermost portion, the floor is not flat and liable to flood, consequently the villages can be built close to the river and are not situated, as is commonly the case elsewhere, upon alluvial fans at the side of the valley.

The type of settlement is also somewhat abnormal, for there are no scattered farms, although the population is Germanic, and such isolated dwellings are typical of Germanic as distinct from Latin peoples in the Alpine area. Finally, it may be pointed out that the Lötschental is exceptional in that it did not suffer a decrease of population at the beginning of the present century, whereas such a decrease was usual in valleys which had neither a large influx of tourists nor an industrial development based on the utilization of water-power; here pastoral work has sufficed to maintain and even to increase the population.

DISCUSSION

Before the paper the PRESIDENT (Admiral Sir WILLIAM GOODENOUGH) said: From time to time we devote an afternoon to the consideration of one particular regional unit in all its relations and correlations of geology and morphology, and the human aspect as well. Indeed, the only aspect that we do not discuss is the denominational. This afternoon Professor Unstead, who is well known to all of you, will describe that part of the country of Switzerland which is known as the Lötschental. Professor Unstead.

Professor Unstead then read the paper printed above, and a discussion followed.

The PRESIDENT: Mr. Weston, of this Society and the Alpine Club, is intimate with the area about which we have heard, and I will ask him to address us.

The Rev. W. WESTON: I have long been interested in the Lötschental from the point of view of human characteristics, and I have listened with veneration not unmixed with awe to a scientific exposition of the features of that wonderful valley of which formerly I was ignorant. It is many years since I first went into the valley, and each time I have penetrated into its recesses I have been more and more struck with the extraordinary beauty of the scenery and of the very interesting characteristics of the inhabitants. I was surprised to hear in the concluding words of the lecture that they are of Germanic origin, because I have always understood that this portion of the Lötschental and the adjoining valley of the Gasterntal are inhabited by people who were originally of a quite different type. We know that about the year A.D. 460 the Germanic hordes burst through the Roman fortifications on the shores of the Danube and made their way down on to the northern slopes of Switzerland. There were, on the other hand, people on some of the southern slopes of the Alps, who I think certainly included the inhabitants in the region under discussion, and who came up at some time or another from the plains of Lombardy; and I must say that those who are familiar with the people of this region cannot see much difference between them. The Lötschental folk are of a much more Italian type than their neighbours, who are in the main more Teutonic in habits, culture, and religion, as well as far more progressive in many ways.

The lecturer has referred to the inscriptions which are often carved, sometimes just painted, upon some of the better chalets, and they are rather remarkable. If you give some attention to these types of inscription over the chalets you will see that those in the Lötschental are of a much more devotional character than is usually found in a great many of the inscriptions on the opposite side of the Lötschberg ridge. The progenitors of these people coming up from the plains of Lombardy, crossing the mountain passes into the Rhone valley, and penetrating up into the Lötschental, are represented by folk very much more conservative, and have maintained what some have called superstitions, at any rate habits of mind, towards the powers of Nature and so on, which are very different from those we are familiar with amongst the German population of the Alps.

Until comparatively modern times there has been hardly any intercourse between this valley and the neighbouring ones of Gastern and Kandersteg. There is practically only one pass leading from the Lötschental into the valley on the other side, and that is over the Lötschberg itself. That was formerly notorious for the destructive avalanches in its neighbourhood. A cross was erected there to act partly as a memorial of past disaster and partly as a warning to those venturesome enough to want to cross from the one valley to the other. It is a curious fact that although there is here one of the most up-to-date railways in the whole of the Alpine regions debouching from the Goppenstein end of the tunnel at the mouth of the Lötschental, and you can get some sort of light carriage to take you up from Goppenstein some 6 miles as far as to Kippel, from there you have to walk, unless you can go on mule-back. Near the Fafleralp, at the junction of the two lateral valleys of Inner and Outer Faflertal, is one of the principal "Nature Reserves" of Switzerland.

The study of the Lötschental and its inhabitants affords an unusually attractive example of the fact that it is among the pastoral populations who live retired and comparatively isolated in the remoter valleys that will usually be found the remnants of types of the ancestors of the Swiss people.

Professor E. G. R. TAYLOR: So far as I remember it is about twenty-five years

since there has been any opportunity of discussing in this Society the demarcation of regional boundaries, and it will be, possibly, another twenty-five years before there is another opportunity. The President has told me that I am allowed two minutes, so that I have to get the observations of fifty years into that time.

Systematic classification is, of course, essential to the progress of geography as a science, and Dr. Unstead's paper has brought out the two bases possible for such classification, that is to say, the one which starts with morphological units on the principle adopted by Professor Herbertson, and the one which bases the divisions on what is termed human use. Since the morphological units are, as far as human time is concerned, relatively static, it seems that we should concentrate on those in the first instance and then superimpose upon them the dynamic boundaries that have to be re-plotted every few years, that is to say, the boundaries drawn according to human use of the area in question. The longitudinal Lötschental was obviously, as we saw it on the map, although we did not see the topographical map, a morphological unit, a very sharply defined one, and, as a matter of fact, I could not quite understand why Dr. Unstead complicated matters by including with it, and then separating out from it, that transverse valley which morphologically and genetically is, of course, a geographical individuum, if one may use that word, in itself.

A further point that I should like to question Dr. Unstead about is the detail of the demarcation of his longitudinal boundaries within the morphological unit of the Lötschental proper. He spoke of the valley bottom as being one such region which he would demarcate, but did not give us any indication of his method of drawing his boundary, and it is a very dangerous thing, I suggest, if we are to attempt any systematic classification of geographical regions, to draw *ad hoc* boundaries without any definite criteria to go by. Similarly with regard to the upper boundary, he chose the limit of vegetation, whereas since he started with the morphological unit of the valley he should have chosen the morphological boundary of that valley, that is to say, the line, indicated by the break of slope, marking the area of actual incision of the valley.

Another point that I would raise with Dr. Unstead is the question of introducing principles of causation when he is attempting the delimitation of boundaries with the object of geographical synthesis. In his own description of the Lötschental I noticed that a big set of causal factors was not dealt with, that is to say the climatic character of that valley which I suspect must be peculiar to the valley itself owing to its configuration; and when Dr. Unstead did introduce the question of causation, or, rather, suggestions of causation, I was not quite happy about his explanations. A particular point I noticed, although nothing to do with climate, was his suggestion that the former settlements on the shady side of the valley were abandoned because of the avalanches and absence of sunshine; the people migrated to the more sunny slopes on the other side of the valley. But surely the avalanches and absence of sunshine were no new factors. What one would like to have explained is why the people settled in the past time on that unfortunate threatened side at all, not why they left there. There may have been already a complete occupation of the better-situated lands; historical research is necessary.

There is one last point I should like to raise, although it arises only indirectly out of the paper, and that is the need there is for an exact survey of all such natural boundaries as do exist, in order to advance this very important matter of delimitation of geographical regions and geographical units in different parts of the world. We do still need a very great deal of field work in the direction of the mapping of such visible natural boundaries as snow-line, tree-line, vegetation-line, and so forth. It is, I think, very much to be deplored that although there has been a

century of travellers bringing back to this Society reports, and bringing back maps and excellent topographical detail, so little attention is given by many of these travellers to the bringing back of detail with regard to what we may term the geographical complex, the lay-out of vegetation, human settlements, land utilization, and so on. Travellers often take very great pains before they start to equip themselves as topographical surveyors, and it would seem possible with the co-operation of the Society that those who are active in that respect should also equip themselves before they start with some of the technique of regional survey, and so be able to bring back material which could be used by those at home in their studies for the demarcation of what we are so anxious to demarcate —actual regional boundaries.

Professor C. B. FAWCETT: It is obvious that much of the earlier study of these natural or geographical regions started from quite the opposite end to that suggested by Professor Unstead. Twenty-five years ago Professor Herbertson began his study of major natural regions by a survey of the world as a whole and an attempt to sub-divide the great land surfaces on the basis of climatic conditions. Coming to more recent times, we had in this hall in September last Sir Halford Mackinder's survey, not on a physical basis, but mainly in relation to distribution of population; and he marked out the great populous regions of the world in two main regions, East and West. That method of starting with the world and working downward has produced some interesting and valuable results, but it is, I think, equally valuable to use the alternative method, which starts with very small areas, so small that one can regard them as almost uniform, and tries to find out their limits, how they fit together, or may be fitted together, for the development or formation of different regions for study and for convenient description. I take it that the whole basis of the value of the regional method in geography is that by getting hold of units of manageable size, manageable in the sense that they can be understood without too much difficulty, we can classify the innumerably various factors of the Earth's surface in such a way as to make them comprehensible. If we take them as isolated facts they are far too many for any one brain to hold, still less see them in any relation whatever. The value of this study is its attempt to classify such facts so that we may grasp and hope hereafter to understand them.

Dr. Unstead has illustrated for us an attempt at getting the smallest of the units. He started with a unit which is, as Miss Taylor said, very definitely a physical one: he started off with the valley, which is obviously a physical unit, and within that it appears he went through sub-divisions mainly based on physical conditions. There is some reference to the vegetation, but except in the outer boundary of the valley as a whole the vegetation was not to be the deciding factor in his sub-divisions. I am not sure how far Dr. Unstead really intended to make his regions primarily physical. I should like to ask a question of him, as to whether he had not in mind, though it was put in fact second in most of his description, the extent to which man has been able to make different use of the different areas as the primary criterion of the separation into small units. It is a different point of approach. That however is the main question I should like to ask.

One other quite minor matter occurred to me in reading the paper and in listening to it, and that was one Mr. Weston has also referred to, namely human distribution. The distribution of settlements is described as akin to that of the Latin section of the Alps; but in the paper the names appear to be very distinctly Germanic. There appears to be some difference of opinion as to whether the people are Germanic or Latin in type. Is it possible for Dr. Unstead to give us more definite information on that matter?

Dr. L. D. STAMP: I find most of the points I have noted down have already

been covered, and very adequately, by Professor Taylor. I should however like to say how geographers appreciate a study of this sort, and I wonder if it would be asking too much if, before the paper is published, Professor Unstead would give some indication in the form of a bibliography of the similar studies which I believe have been made of Alpine valleys and published in French or German. It is difficult for people in this country to keep in touch with foreign literature, and a short bibliography would add enormously to the value of this study which is now available for us in England.

Touching once more on the question of regional divisions, it did strike me in reading the paper that Professor Unstead has accidentally fallen into, may I say, a trap which I think has already enmeshed a large number of geographers. When one attempts to divide a region, whether small or large, into its natural units there is a sort of automatic reaction which causes one to choose the salient features which strike the eye first. Thus I notice that Professor Unstead was struck by the limit of vegetation, and he said that should be the limit of his valley; when he came to study the valley he was struck by the fact that there was a trough in the centre and the two sides, and he adopted those as his second division. When he came to the consideration of the longitudinal valley the morphological units presented themselves. He then finally had, as he himself told us in his summary, to return to the fact that the divisions based on economic and human reactions were different from those which he had got by his first method. Therefore he has given us, in addition, a threefold division of the valley into the permanently settled central portion, a surrounding tract with summer settlements and Alpine pastures, and then a higher tract which is of comparatively little importance humanly speaking. He really presents to us in miniature the difficulties which the regional method has brought out again and again.

I should like to know more certainly about the climatic factors, more particularly because of an aspect of human geography, which I think is increasingly important. What are the health conditions in a valley of this sort? How far is the aspect of one side as contrasted with the other of first importance in determining (*a*) the health of the people, and (*b*) their consequent distribution? In discussing the matter only recently with Sir Leslie Mackenzie, I found he had noticed in Highland valleys in Scotland the point which struck me in the glens of Antrim not long ago, that on the southern side of the deeper valleys, where the sun does not appear in winter until something like two o'clock in the afternoon, health conditions were obviously, even to a casual observer, very much inferior to those on the other side. I wonder whether that is possibly the explanation of the abandonment of settlements on the one side and migration to the sunnier, healthier other side.

I should like, in conclusion, to endorse what Professor Taylor has said in that we all hope that in the future travellers may bring back to us from more distant countries something of the order of regional studies. A tremendous amount of work remains to be done, but I would like to emphasize this: that we do not want their information merely because we desire to divide up the world into little units or because we wish to draw lines between those units. We want their information because of the function which I believe geography has to perform in the future. Geography, after all, is the study of the Earth as the environment of man, and we want to get a living concrete picture of different types of environment, whether environment of a very small area and its reaction to the few people living in that area, or of a large area and its reaction upon nations. That is where geographers of the future, in conjunction with economists, have a great work to perform in assisting human progress.

Dr. J. F. UNSTEAD: I am afraid that in the few minutes remaining for me I can

only give the briefest of answers. As regards whether the people are of Germanic origin, certainly if language is taken as a test they are German; as to physical characters, if one judges by coloration of hair and eyes, a considerable proportion of the children do show the Germanic characteristics. Racially the population is probably of mixed origin, but the people regard themselves as of German descent, and from that point of view their type of settlement is anomalous.

The most important matter which has been discussed is the question of the demarcation and classification of regions. Professor Taylor, if I did not misunderstand her, rather suggested an antithesis between a morphological and a human method of demarcation, but I do not think the matter is so simple as that. There are many possible methods of division, based upon single factors, *e.g.* relief, structure, climate, natural vegetation, land utilization, and so on. What I tried to do was to get a method of demarcation which did not depend on any one factor, but showed the combined effects of all the factors. If only one factor is selected and the others are ignored I do not think the demarcation is adequate to geography. It may be appropriate to a particular science, but the business of the geographer is to see the combined effects of all these factors and, looking at them, to say what natural divisions occur. I adopted that conjoint method for the most part, but I made an exception at the end, adding, as it were, an appendix, and making a demarcation upon the single basis of land-utilization; this method has an economic bias, and would be specially appropriate to an economic study. The combined classification, which was my main aim, was largely based, as Dr. Stamp suggested, on what struck the eye, but I refuse to regard that as a "trap"; the eye sees the area as a whole, without the analysis into separate factors, which is in one sense unnatural.

Let me take as an illustration of my method the upper limit of the valley. It was "Vegetation"? Yes, that is a short way of expressing it, but the vegetation shows the combined effects of a number of things: altitude, steepness of slope, climatic conditions, especially temperature and insolation, soil and drainage conditions. The upper limit of vegetation consequently runs round the valley irregularly and does not follow any contour line. Then, when one realizes how man and animals utilize vegetation but seldom go above its limits, it seems justifiable to take the upper limit of vegetation as the boundary of the valley considered as a geographical unit. On the other hand, if the valley were the subject of a morphological study, the vegetation criterion would not be appropriate and one or more purely physical criteria would have to be adopted. Moreover, even in this geographical study I did not in all cases accept vegetation as the distinguishing factor; it was regarded as important in separating the upper from the lower part of the valley bottom, but for the smaller divisions the landforms, frequently because they indicated a change of slope and consequently of soil conditions, plant growth, and land utilization, seemed the best basis of demarcation.

The PRESIDENT: Not only have you given us a very interesting lecture, Professor, but you have also had some very pertinent questions put to you. Remember what Professor Fawcett said about physical and human divisions. It seems to me you must start with the physical, that is the beginning of all things. We stand on the Earth: the Earth is where we live. Start with the physical, and then work on that to all the details. I dare say many of you have heard me say, and have heard my predecessors say, "What is all this investigation and all this search into geography for? It can have but one end. It is not a pure knowledge of this or that only that we search for; it is all for the happiness of man. If we do not regard that as the ultimate object of all our investigations it seems to me that we fall short of our duties." I have in mind the project of having next year a lecture on an area in which I myself am greatly interested: the Peace River Area in

British Columbia. It is in the making, and it will be of great interest and importance that we should hear how it is being made: the growth of a settlement, one day to be a state. What are the factors? How much or how little state help is being given? How do the geographical surroundings affect the settlers? Who are they? What has caused them to go there? How do they live? What are their difficulties? I will not go further. But much is to be learnt if we are to gain from the Earth those places where an ever-increasing population may live in happiness and prosperity.

There are one or two things I would like to say. I have been abroad in many places, perhaps more than some. Why do people move from place to place—from one side of a valley to the other, for instance? The extraordinary thing to me is not why they move but, very often, why they do not move. You see people living in mosquito-infested places, people living on the slopes of Etna and Vesuvius. Do they move? Not a bit. People live in Messina where earthquakes have more than once devastated the town. Do they move? Not a bit. They are governed largely, to my mind, by the fact that it is their custom to live there. That is why they do not move.

As to the necessity for more detailed examination of distant places and the importance, especially to this Society, that explorers and travellers should go abroad with the idea and capacity of bringing back what may be termed detailed regional information, you can be quite certain that that will always meet with the most sympathetic consideration in this Society. But there is one thing to remember, and that is that many people who are fitted to be explorers—and I speak now of places which are not at all known or hardly known—are not fitted to go into details of the kind speakers this afternoon have had in mind, and, as I am reminded by a traveller in the Far East, circumstances of weather and other conditions admit more of general than detailed work. But on the whole study of books on travel show that considerable attention is shown to comparative work.

I had the honour at one of the Society's annual dinners of proposing a certain toast, and I said then, as I say now, that first comes exploration, then comes the examination of the detail—geodesy, geography, all the various things which lead up in the end to what Professor Unstead has given us this afternoon, and that is a detailed examination of one particular area. When one remembers such men as Christopher Columbus and other great explorers, one can realize that it is not given to every explorer to have the same mental capacity of bringing back all those regional descriptions. He goes first, others follow, and then comes the study last of all. So do not blame the explorer too much if you find he does not bring back all that he might. I recall a brother officer of mine who went up the Yangtze and up the Min river; he tied his gunboat up with a rope to a tree, landed with another officer, walked for three weeks, and saw all the country and everything else. Imagine the interest. When he came back I said, "Have you written anything about this?" Oh no, although it was enchantingly interesting he could never bring himself to write anything. But he was the first to go on that piece of exploration. Others will follow.

There is one other point that I would like to mention, though I am not going to give an opinion about it, and that is what arises out of what Professor Fawcett said as to starting with the smaller thing. You may start with the small detailed examination and work up to the big, or start with the big general idea and then consider the smaller area. Those are two schools of thought, and very interesting schools of thought too. In conclusion: All these things are brought out by such lectures as Professor Unstead has given us this afternoon, and those will always meet with great sympathy and be listened to with great attention by the Fellows of this Society. I ask you, Professor Unstead, to accept on behalf of this audience and of the Society our most sincere thanks for your lecture.

THE LIVINGSTONE–STANLEY MEMORIALS IN AFRICA

CAPTAIN C. H. B. GRANT

THE number of memorials erected in Africa to Livingstone or to Livingstone and Stanley now number three, for besides the memorial at Chitambo in Rhodesia (cf. *G.J.*, vol. 61, p. 366) there are now memorials at Tabora and Ujiji in Tanganyika Territory, which have been erected since the British took over the Territory in 1919.

The memorial at Tabora is placed at the site of the ruins of the tembe in which Livingstone and Stanley parted company when Livingstone accompanied Stanley as far as Tabora on his return journey from Ujiji, and commemorates this date and the date of their meeting at Ujiji, although the date quoted for the latter event is inaccurate, being given as 28 October 1871 instead of 10 November 1871. Near the memorial is to be found the grave of Shaw, and this grave has been made up and a cross erected. The work of the memorial and grave was carried out by the local Government departments.

At Ujiji stood the mango tree under which Stanley met Livingstone on 10 November 1871; but it was not until the Belgians occupied Ujiji in 1916 that any action was taken to commemorate this historic spot. The Belgians erected a cement bench around the tree and inscribed on it the names of the explorers and the date of their meeting. In 1921 this was removed as it was thought its weight was unduly pressing on the bole and roots. In 1924 the tree was surrounded by stone pillars and rails and that part of the cement bench containing the Belgian inscription was placed within the compound. When I took over charge of Ujiji in 1924 as Administrative Officer I moved to have a memorial erected to commemorate the meeting of these two explorers, with the final and most satisfactory result that in 1928–30 a memorial was erected on the instructions of the Tanganyika Government, for which a bronze plaque was presented by the Royal Geographical Society. The mango tree, which was fast dying, was cut down in 1930 and a section has been placed in the Museum of the Society.

At the request of the Society, and by permission of the Tanganyika Government, efforts which eventually proved successful were made to obtain grafts from the tree, as owing to its great age it was no longer bearing fruit. The first grafts were obtained and established in tins, but when I returned from leave from Europe in 1927 they had all died through lack of supervision and watering, so that a fresh start had to be made, by no means an easy matter, as it was by this time extremely difficult to find suitable shoots for grafting. Finally six grafts were established, and four of these have been planted at some distance from the four corners of the memorial; a fifth has been planted in the open space in front of the Residency at Kigoma, and the sixth was sent home to Kew but has since died. I last saw these young trees in December 1930, and one needed the fencing around it reinforced to prevent stock damaging it; the other three were doing well, as was the one at Kigoma.

In Livingstone's day the water of the lake came very close up to the tree and formed the Ujiji creek as recorded by Hore and as shown in the frontispiece of his book ('Tanganyika,' 1892).

The tree with staging for propagation of shoots from branches, 1928

The Mango tree at Ujiji in 1921 with the cement bench and inscription erected by the Belgians

The memorial and the dying tree, 1928

The completed memorial, 1930, with the Belgian inscribed stone and one of the four young mangoes in protecting fence

Ujiji town and its environment have changed since Livingstone and Stanley's time; the town has grown and the lake receded from its former level. Kigoma, as a large and flourishing port 5 miles to the north and connected by rail with Dar es Salaam, has made great strides since 1921, and now boasts a deep-water wharf with cranes and double-storied godowns, a wireless station, electric slipway for ship repairs, and many other modern amenities.

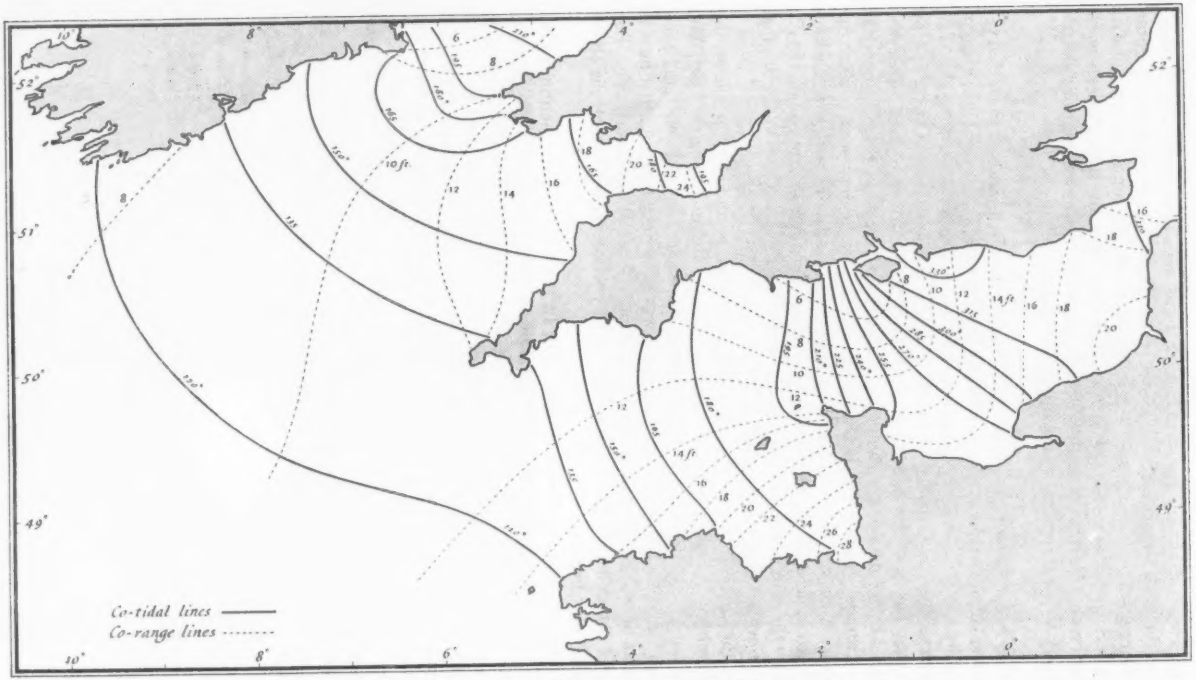
Note by the Editor G.J.—It will give the Society much pleasure to see that the scheme for a permanent memorial to Livingstone and Stanley at Ujiji, inaugurated by our Belgian allies soon after the capture of the town during the War, and developed by Captain Grant when he was Administration Officer at Ujiji in 1924, has been brought to completion. In front of the place where the original mango stood now stands a graceful obelisk erected by the Tanganyika Government, bearing the bronze plate which this Society sent out for the purpose some years ago. It has the inscription, "Under the mango tree which then stood here H. M. Stanley met David Livingstone 10 November 1871"; and by the care of the Tanganyika authorities four descendants of the original mango will in time make a small grove around it.

In the *Journal* for May 1923 (vol. 61, p. 369) at the end of an article on the Chitambo monument, we noted that the British Commissioner at Ujiji, Mr. Longland, had with much regret been compelled to remove the concrete bench placed by the Belgians in 1916, because it was killing the tree, and that he was anxious to replace it by a cairn or monument with a suitable inscription. The project descended to his successor at Ujiji, by whose efforts it took the shape which it now bears.

To revert to the Chitambo monument: In the article above mentioned we dealt at some length with its condition, as described by Mr. W. J. W. Roome, of the British and Foreign Bible Society, and in a letter from Mr. Moffat, of the Livingstonia Mission, forwarded by Mr. Cookson, the Commissioner at Serenje. The monument needed some repair and a better railing to protect it from animals. The correspondence revealed the curious fact that two of the four bronze plates had never been fixed: while the two which had been placed on the monument had suffered because some of the letters, which were soldered on, not cast in the plate, had come loose.

Now the Society has in trust a small sum of money for the maintenance of the memorial, and desires to remedy this bad defect by having new plates properly cast: the intention was mentioned by the President (Lord Ronaldshay) in his address to the Anniversary Meeting on 28 May 1923. Inquiries were made for the size of the plates; but the monument is rather far away from the present road, and the necessary measurements could not easily be obtained. The project has therefore somewhat fallen out of mind; but the completion of the Ujiji monument must revive it, and further inquiries will be made for the details required before it can be renewed.

stone and one of the four young mangoes in protecting fence



Tidal chart for the English and Bristol Channels

NEW TIDAL CHARTS FOR BRITISH WATERS

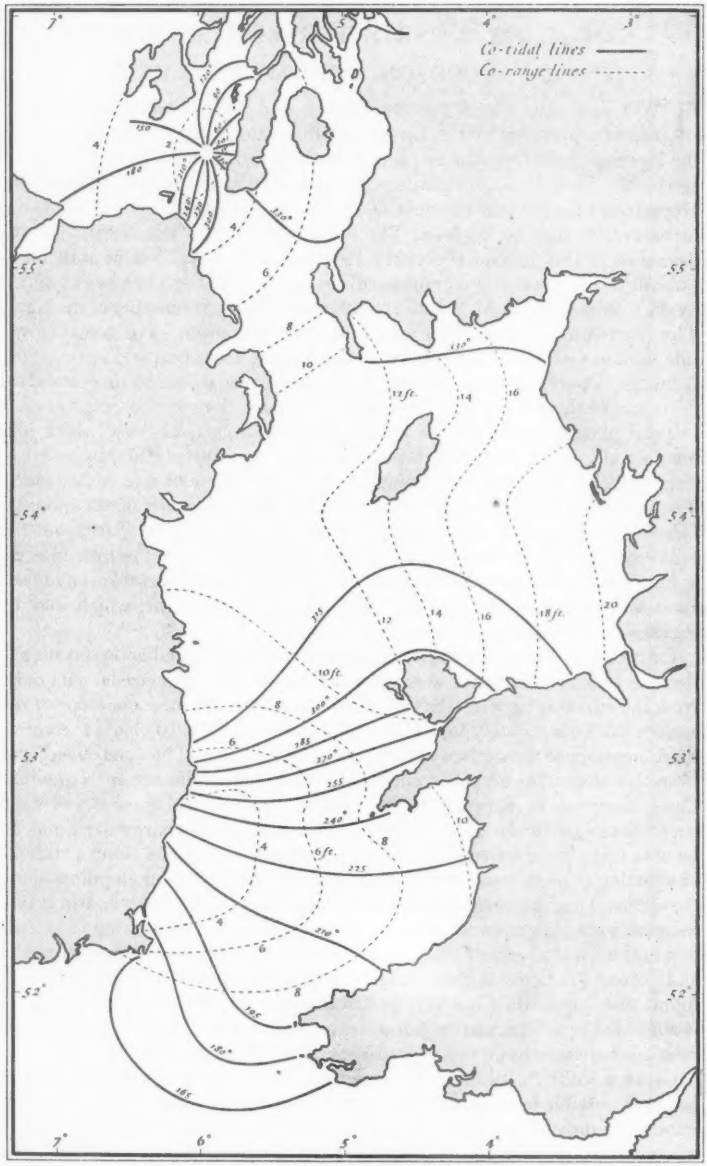
DR. A. T. DOODSON AND R. H. CORKAN, B.SC.

TWO new tidal charts for the English and Irish Channels have been recently prepared at the Liverpool Observatory and Tidal Institute for the Hydrographic Department, supplementing similar work done some years ago for the North Sea. A single chart has now been issued by the Hydrographic Department for the seas adjacent to the British Isles so that the tidal phenomena can be seen as a whole. The portion relating to the North Sea was described in this *Journal* (February 1924, vol. 63, p. 134) and permission to publish in this *Journal* illustrations of the two new sections has been granted by the Controller of H.M. Stationery Office and the Hydrographer of the Navy. The charts only give accurate information for the mean lunar semi-diurnal tide, and in order to make it of more general use from neaps to springs, the Admiralty Chart gives time differences along the co-tidal lines on three standard ports for the three main areas, with ratios of ranges along the co-range lines.

Tidal phenomena out at sea are represented by co-tidal lines (which join together all points at which high water occurs simultaneously) and by co-range lines (which join together all points at which the range of tide is the same). The co-tidal lines are generally related to the time of transit of the moon at Greenwich, but in the illustrations the interval between the transit and the following high water is given in angular measure; to obtain the time interval in hours the angles should be divided by 28·984°. The ranges are given in feet. Both sets of figures relate to the principal tidal constituent, which may be regarded as approximating to the average tide.

Practically all the charts hitherto published have been based upon speculative theories as to the motion of water in a channel or sea, using coastal data only. Now the relations between the tidal currents and the synchronous slope of the surface can be accurately formulated, and from the old tidal charts the corresponding slope of the surface of the sea at any instant could be determined, and from this slope the currents could be deduced. These did not correspond to those observed in nature. By the reverse process, taking observed tidal currents at a particular place the slope of the surface at a particular time can be obtained. If the currents be known at a number of points along a straight line joining coast to coast, then the gradients of the surface at all points along the sectional line can be deduced. If now the coastal elevations be known at that moment a simple graphical method suffices to give a curve showing the elevation of the sea at all points along the sectional line, with correct terminal points and correct gradients at the stations at which currents were observed. It is found that this method is a very practicable one and free from ambiguity. It is not based upon speculation but upon well-established (and almost obvious) relations between the elevation-gradient and the tidal currents.

Given a sufficient number of current stations to form a network, then it becomes possible to fill in the details over the whole channel or sea. A certain number of difficulties occur, of course, when the information is scanty, or if it is obtained from abnormal stations where there are prominent headlands, races, or overfalls.



Tidal chart for the Irish Channel

The Hydrographic Department undertook to obtain current-observations on three sectional lines across the Atlantic entrances to the channels, but the current data have been extracted mainly from the Admiralty publication 'Tides and Tidal Streams,' and the coastal observations, of course, from the Tide Tables.

These charts differ in many respects from those previously published. It had become customary to consider tidal waves travelling faster in the middle of the channel than at the sides, but this has been lately shown to be fallacious, even in an infinitely long channel. Consequently the co-tidal lines were presumed to be very much curved inwards. The charts however show beyond the shadow of a doubt that if anything the lines curve outwards. This reversal of curvature of the co-tidal lines means that in midchannel east of the Isle of Wight the time of high water indicated by the new chart differs by as much as three hours from the times indicated on other charts; similarly at the entrance to St. George's Channel there is a very pronounced outward curve in the line for 165° (5·7 hours). The corresponding line on older charts is generally shown as having a very pronounced "peak" to the north.

It may be remarked, in conclusion, that most atlases give charts of co-tidal lines for British waters and that these give very erroneous conceptions of the true character of tidal propagation.

ZIMBABWE

THE ZIMBABWE CULTURE: Ruins and Reactions. By G. CATON-THOMPSON. *Oxford: Clarendon Press* 1931. 10×7 *inches;* xxiv+300 *pages; illustrations, sketch-map, and plans.* 25*s*

IN spite of the continuous interest and fertile speculation which the ruins of Southern Rhodesia, and particularly Zimbabwe, have excited ever since they became known to Europeans about sixty years ago, the problems of age and origin which they present have only twice been investigated with the systematic thoroughness and exactitude of the trained archaeologist. Both of these investigations were carried out at the instance of the British Association; the first in 1905 by D. Randall MacIver, and the second in 1929 by Miss G. Caton-Thompson, with the assistance of Miss Norie as surveyor and Miss K. M. Kenyon as photographer. The present volume embodies the results of the latter expedition, and no pains have been spared, whether in text, documentation, or illustration, to satisfy the most exacting standards of modern archaeology. Even aerial photographs by the South African Royal Air Force are included.

The thoroughness of the excavations, the lucidity of the author's exposition, and the pervading sanity and impartiality of her judgment render this work a landmark in Rhodesian archaeology, and indeed a model of archaeological method in general. In the words of Professor J. L. Myres, from whom, as General Secretary to the British Association, the inspiration and momentum of the expedition were derived: "As a record of scientific achievement Miss Caton-Thompson's book speaks for itself."

MacIver's 'Mediaeval Rhodesia' (1906), excellent as it was, and indispensable as it still remains, left certain questions in doubt and gave rise to heated controversy. It was with the object of settling the question of dates with the utmost

degree of finality permitted by concrete and indisputable evidence that Miss Caton-Thompson entered the arena. In her summary of conclusions she states: "The result of concentrating the excavations of 1929 almost entirely upon the collection of evidence bearing upon the question of the lower dating limit for the primary occupation of the sites dealt with, which I believe to represent a fair sample of the whole, has enabled me to fix a *terminus a quo* for the erection of the buildings themselves well within the Christian era."

Broadly speaking, Miss Caton-Thompson confirms MacIver's verdict that the buildings were African in origin and mediaeval in date. This verdict is so abundantly justified, not only on archaeological, but also on historical and cultural grounds, that it is hardly likely to be seriously disputed hereafter by any impartial student. No evidence whatever was found in support of Bent's and Hall's romantic theories of ancient Sabaean or Phoenician origin during the first and second millennia B.C.

But although MacIver's findings are thus substantiated, they are both amplified and modified. The new excavations, carried down for the first time to bed-rock, both in the Acropolis middens and beneath intact cement floors in the buildings, have yielded evidence which assigns the earliest building period to about the eighth or ninth centuries A.D., *i.e.* about five centuries earlier than MacIver's date. This re-dating is due to the discovery of quantities of minute glass trade beads in positions proving them to be anterior to, or contemporary with, the construction of the main buildings of Zimbabwe. Twenty-five years ago beads had not acquired their present importance as "sensitive chronometers"; too little was known about them, and they played little part in MacIver's evidence. Some of these beads are now known to be of early mediaeval South Indian and Malayan origin, and this accords well with the records of early Arab trade between India and the East African coast.

A very valuable study of the beads, illustrated by figures and a colour-plate, is contributed in an appendix by Mr. H. C. Beck. The Sabaean "die-hards" may possibly find crumbs of comfort in the cautious qualifications with which Mr. Beck safeguards some of his attributions. Certain black beads admittedly find their nearest known analogies in the Mediterranean area, and might in themselves be dated a few centuries B.C.; but they are associated at Zimbabwe with others of mediaeval date, and the dating of groups can obviously not be earlier than the latest member of any group. And even where we only have probabilities (albeit very strong ones and carefully balanced) it would be absurd to reject them simply because they are not certainties. The study of beads is still only in its infancy, and it is to be hoped that further research will result in narrowing down dates and sources with even greater precision than is possible at present.

It would be impossible in a review even to summarize all the interesting new discoveries made in the course of these excavations. Chief among them, perhaps, are the clear establishment of two (probably continuous) periods of occupation characterized by different types of pottery, both Bantu; and the disclosure of flagged paths leading to the wall foundations, which the author is almost certainly right in explaining as for the use of the builders during the wet season. Her ingenious hypothesis, whereby the short radial walls, hitherto regarded as fragmentary, are explained as unaltered partitions centering on circular wattle huts, now perished, provides a very neat solution of a puzzling problem. Her restoration plan is thoroughly convincing, and the fact that this kraal arrangement finds close parallels in Uganda and elsewhere adds yet another proof of African origin.

The investigation of the ancient gold and copper workings seemed unlikely to yield any archaeological evidence of value, and was wisely not attempted in

the limited time available. The question of a chronological equation between mines and ruins remains unsettled. The ruins are not situated near to, nor in any obvious relation to the gold-bearing areas, so that the quest of gold cannot be regarded as their *raison d'être*. The solution of the ancient mining problem, as the author points out, is far more likely to be found by excavation of some of the early Arab seaports, such as Sofala, where datable oriental wares must have been imported, which are only awaiting the archaeologist's spade to tell their story.

In addition to the main work at Zimbabwe, surveys and sample excavations were carried out at a number of other sites in the Sabi Reserve, viz. Matendere, Gombe, Mshosho, Chiwona and Hubvumi. None of these, except the first, had been previously properly described. The last two, "typical hilltop strongholds of the Acropolis style," belong probably to the earliest Zimbabwe period, on grounds of their type of architecture, cement, and the beads found. Obviously there is still a large field of work here awaiting future excavators. One of the enclosures at Dhlo-Dhlo was tested and definite evidence of Bantu construction and occupation as late as the seventeenth century was obtained. These conclusions are based on skeletal material and pottery; late Ming porcelain, and a Dutch gin-bottle provide a precise *terminus a quo*, and confirm MacIver's dating.

Not the least valuable part of the book consists in the series of appendices by leading authorities. Mr. Beck's report on the beads has already been mentioned. The others include "Notes on the Metallurgical Analysis of Objects," by Professors J. H. Stanley and C. H. Dresch; "Report on the Dhlo-Dhlo Skulls," by Sir Arthur Keith; "Notes on the Bavenda and their connection with Zimbabwe," by H. Stayt, who finds many analogies between this living Bantu tribe and the old builders; and, finally, a well-written and carefully documented "Sketch of the Exploration and Settlement of the East Coast of Africa," by Miss K. M. Kenyon. To complete the tale, there is an inventory of objects, an index, and a very full bibliography.

If the combined and mutually corroborative efforts of all these specialists do not succeed in laying King Solomon's Zimbabwe ghost, nothing ever will. Those who still regret the passing of a cherished but outworn romance should find comfort in the author's concluding sentences: "The interest in Zimbabwe and the allied ruins should, on this account, to all educated people be enhanced a hundredfold; it enriches, not impoverishes, our wonderment at their remarkable achievement; it cannot detract from their inherent majesty, for the mystery of Zimbabwe is the mystery which lies in the still pulsating heart of native Africa."

H. J. BRAUNHOLTZ

REVIEWS

EUROPE

ST. LEONARD'S CHURCH AND THE ANCIENT TOWN OF HYTHE. By H. D. DALE. *London: John Murray* 1931. 9×6 *inches;* xii+107 *pages; illustrations by* A. H. HALLAM MURRAY. 2*s* 6*d*

The Cinque Ports with the two "ancient towns" of Rye and Winchelsea can boast an array of noble churches. St. Leonard's at Hythe is second to none; its superb Early English chancel can hardly be matched in any parish church. Yet down to 1844 this was but a chapel of Saltwood, where the castle was a residence of the archbishop. But Lympne, not Saltwood, the author declares to be the true mother of Hythe. It was the silting up of the Roman Portus Lemanis that compelled the Saxons to construct a hithe or quay nearer to the mouth of the lagoon. The town that grew up at this spot attained considerable dignity as a naval port; but in the fifteenth century we find the citizens hard at work digging to free their harbour from encroachments. Its mouth seems to have been pushed gradually eastwards "by casting of shinggil" as Leland describes, so that there was a mile-long channel towards Folkestone. It is not made clear in this book exactly how and when the haven entirely disappeared, leaving the town half a mile from an unbroken coast-line. A good plan of Hythe should be included in a future edition with some indication of the lie of the old inlet.

Most visitors to Hythe and its church remember it for the astonishing collection of skulls and bones in the crypt under the chancel. This crypt, we are told, was really a subway formed like the side doorways in the south porch to make possible a continuous processional route round the church which was closely hemmed in by roads on the east and south. The old theory that the bones were gathered from a Saxon-Danish battlefield was disproved by a careful investigation instituted by the author when vicar. Professor F. G. Parsons considered that two-fifths of the skulls examined were those of adult females and about one-seventeenth those of children. Pieces of pottery and other objects found among the human remains proved to be mediaeval. The conclusion reached is that skulls and large bones disinterred at the digging of new graves in what was a small churchyard were placed in this convenient charnel-house, which, as the author points out, was right under the high altar. No doubt many of them were turned up during the devastating visitations of plague and the Black Death to which Hythe was sadly subject, though not surprisingly in view of the sanitary conditions revealed by the quaint quotations from the Court Rolls. J. H. R.

SOUTHAMPTON: A CIVIC SURVEY: being a Report of the Civic Survey Committee of the Southampton Civic Society under the chairmanship of Brigadier E. M. JACK. Edited by P. FORD. *Oxford: University Press (for the Southampton Civic Society)* 1931. 14×10½ *inches;* xii+100 *pages; illustrations and plans.* 30*s*

This volume is a report of a survey of Southampton carried out entirely by volunteer workers. More than a score of writers have collaborated. Of these roughly a third are members of the University College and another third municipal officers. Eleven of the maps were produced by the Ordnance Survey. These maps are overprinted on a base map in faint grey, on a scale of 2 inches to 1 mile. One of these maps (Income by Streets) is not numbered, and on it the registration of the colours is not accurate; the rest are up to the O.S. standard, except that in all of them the base map is so faint that it is difficult to read it.

The History which forms Chap. I is a masterly summary by the late Dr. J. W.

Horrocks. Miss Withycombe's section on the Place-Names contains many points of interest. It may be suggested that the absence of any "solid" rock near Rockstone Lane indicates that the derivation from a personal name is the more likely; the picturesque "popular" Rogues' Den suggested by the spelling Rogesden is, perhaps rightly, not even mentioned. It is suggested that the recent change from Burgess Street to Burgess Road should be reversed, a suggestion which might be carried further; for the town would gain by the restoration of such names as Porter's Mead and English Street.

The section which is likely to be of most direct interest to geographers is that on Land Utilization, by Professor Rishbeth. This is based on survey and mapping of the distribution of industrial, shopping, and residential areas, open spaces, institutions, and rural occupation of land within the area, which extends beyond the borough boundaries. It brings out very clearly the concentration of the industries on the Docks and the radial arrangement of the rest in a semicircle round them. There is also a tendency for the industries to spread along the water-front to north-west and south-east. The writer notes a marked discontinuity between the town and its neighbourhood. In this respect it resembles Hull and other ports at a distance from the populous areas which form their economic hinterlands.

Southampton is mainly a passenger port and the "big liner" port of Britain. These characters appear vividly in the very clear and well-illustrated chapter on Port and Dock Development by Mr. Wentworth-Sheilds. In 1930 the numbers of packages of mails, tons of cargo, and passengers dealt with each exceeded a million. The two first refer to overseas trade; but the passengers were almost equally divided between overseas and local, *i.e.* mainly to and from the Isle of Wight. Southampton had thus about a sixth of the total overseas passenger traffic of the kingdom, with a majority of the trans-oceanic and a fair share of the cross-Channel passengers.

Some of the suggestions for providing for the future growth of the town allow for the decline in the birth rate and a stationary population in the near future; though there is no recognition of the probability of actual decrease. This is best seen in the section on Education by Mr. F. L. Freeman, in relation to the provision of new schools. But other contributors write as though a continuation of the rapid growth, which has doubled the population in the past generation, is inevitable. It would be of interest to know the estimated cost of all the desirable improvements suggested.

In spite of the number of the writers the book is a whole. The unity of its theme and the skill of its editor have held it together; there is only one chapter which might have been written of some other town. The Southampton Civic Society and the editor are to be congratulated on the production of a valuable survey of present conditions in their port and town, which may well serve as a stimulus to other towns to go and do likewise. C. B. F.

BELGIUM AND LUXEMBURG. By KARL BAEDEKER. Sixteenth Edition. *Leipzig: Karl Baedeker* (*London: George Allen and Unwin*) 1931. 6½×4 *inches;* 1+366 *pages; plans and maps.* 12*s*

We can have nothing but praise for this new edition of a well-tried handbook. It is thoroughly up to date, severe and practical, and easy to use. Baedeker's aim has always been to indicate what the traveller ought to see and leave him to like or dislike as he chooses. There are notes on air travel and motoring—here a warning might have been added as to the condition of some of the Belgian roads, which can be very hard on light cars—and in the historical introduction to each important centre the traveller is directed to recent English works on the subject.

Many of the Belgian towns now prefer to use Flemish for the names of their streets, which is puzzling to foreigners. The maps of Bruges, Ghent, and Antwerp still retain the French names, but the index to each map gives the nomenclature in French and Flemish, which meets a very real need. The section on Luxemburg should serve to draw an increasing number of visitors to this delightful district. M. L.

A JOURNAL OF MY JOURNEY TO PARIS IN THE YEAR 1765. By the Rev. WILLIAM COLE. Edited by FRANCIS GRIFFIN STOKES. With an introduction by HELEN WADDELL. *London: Constable & Co.* 1931. 9×6 *inches;* xxxii+410 *pages; plan.* 16*s*

From his expedition to Paris in October 1765, the Reverend William Cole gleaned extraordinarily little regarding the life of the country he was visiting. At least, that is the impression one gets from his diary. The book holds one—it is difficult to say why—and one reads page after page, only rarely rewarded by the record of some impression of a landscape or a scene of activity. "St. Omer," he says, "is large, well-built with Stone, Streets large, well-paved and clean, but there does not seem to be any great Traffic in it." We note that he travelled from Lille to Douai by "Passage Boat"—"a large, unweildly Vessel, but perfectly commodious," in the company of "several Abbées & many Trades-People bound for Douay." We are not surprised to learn that the passage was "slow and unlively." He is naturally impressed by the great stretch of open champagne country, which he likens to "that kind of Country which is about my Lord Godolphin's at Gogmagog Hills in Cambridgeshire, and like many Parts of Hertfordshire . . . being a chalky Country thro'out." "The River Oise" (at Pont Ste. Maxence) "was full of Boats and Barges with Corn, it being reckoned one of the largest and best Corn Markets in France."

In Paris his attitude is distinctly carping. He disapproves of contemporary French architecture, "not at all suited to my Ideas of it," and gardens and pollard trees; but he finds the butter and bread better than at home, and he thoroughly approves of French food and relishes the Vin de Beaune and the Cyder of Normandy, apparently to the detriment of his stomach. The food, he says, is "abundant, varied and good, for those who can pay for it." Having reluctantly admitted so much, he hastens to add: "We have, thank God, what is much more valuable, a more beautiful Country, even in Winter, Climate more moderate and such a Verdure as is unknown to the very best spots they have in France." The Seine has no charm for him. He refers to it as "that beastly River" from which his linen returned to him dirtier than when it first went there.

The abruptness of the rise of Montmartre arrests his attention, but he dislikes the bareness of the isolated block of Brie limestone: "A miserable, dreary, barren, sandy and brown Hill . . . with a great Number of Windmills upon it to add to its natural Deformity; it has more the Look and Appearance of an artificial Hill, raised out of the Dirt and Filth of the neighbouring City, than a beautiful, rising Ascent, covered with green Hedges, Grass," etc., and further likens it to "the great dirt Hills about Pancras or Whitechapel"—except that the latter have the advantage of verdure "to hide their original Meanness." "The Outskirts of Paris are not to be mentioned except to be laughed at . . . hardly a Cow to be seen for miles. Yet the People, amidst all their Beggary, Poverty and Misery, seem to be happy and contented."

Cole experienced the inevitable *malaise* of most English people transplanted from the verdure and gentle contours of our own southern counties to the bare, open spaces and semi-continental climate of the limestone high plains of northern France. It is only with a deeper understanding of the land and people that these

wide ploughlands make their full appeal to the mind and senses. Cobbett would have looked at them with a very different eye. H. O.

THORPE'S YACHTSMAN'S GUIDE TO THE DUTCH WATERWAYS, including the Zuider Zee and the Friesland Meers. Rewritten by C. E. A. L. RUMBOLD. *London: Edward Stanford* [N.D.]. 10×6 *inches;* 96 *pages; plans and map.* 10*s* 6*d*

This work was first published more than a quarter of a century ago and this new edition was much needed. The gigantic works which have been in progress since 1922 in the Zuider Zee require that Part II be completely rewritten. The dike running from Noord Holland to the Friesland Coast is about two-thirds constructed and will be completed in this summer. On p. 58 there is a general plan for enclosing and reclaiming the Zuider Zee which is of great interest both to the general reader and to the yachtsman.

The suggestion that Flushing be made the first Dutch port of call is wise and also that small craft should coast as far as Ramsgate or Dover and then make Calais, Dunkerque, or Ostend before setting a course for Flushing: few yachtsmen with experience of the formalities for yachts entering French canals will think it worth while to go by canal from Calais to Ostend. Holland and Belgium welcome the cruising yacht and give every facility for its passage provided the British Board of Trade certificate of Registry is produced. Captain Rumbold gives an example of a suitable yacht for cruising: a motor yacht of 37 tons T.M. with auxiliary canvas; but in these impoverished times three or four people can cruise comfortably and cheaply in a 7–8-ton cutter drawing 4 feet, with the mast stepped in a tabernacle and an auxiliary petrol motor. A table gives the metric system in relation to sea-miles; marginal notes converting into knots speed limits expressed in metres per minute would be helpful. Detailed information necessary for an extended cruise will be found in this valuable guide which will meet with the same cordial reception as its forerunner. H. M. E.

LÄNDERKUNDE DER NIEDERLANDE UND BELGIENS. By WALTHER TUCKERMANN. (Enzyklopädie der Erdkunde. Edited by OSKAR KENDE.) *Leipzig: Franz Deuticke* 1931. 10×7 *inches;* x+158 *pages; maps. M.*12

Professor Tuckermann's main theme, running through a geographical account of the cultural and economic development of Holland and Belgium, is the creative force developed by the peoples of the two Netherlands, which enabled them despite the lack of natural frontiers to establish themselves as independent entities on the periphery of Central Europe. This creative force he ascribes largely to the geographical conditions inherent in a situation at the converging point of central and western European influences, but in a great measure also to the age-long struggle for existence with the land and sea waters.

Athwart the main cross-roads of north-west Europe an active trading intercourse could not fail to develop, and, accordingly, there arose, in the triangle between Paris, London, and Cologne, the most remarkable development of independent trading centres since the time of the Greek city states. Multiplication and development of means of transport has but served to intensify the "bridge" nature of these lands, concentrating the traffic on fewer but ever-growing centres at the junction of sea and land routes. Thus in these two countries are concentrated the most highly developed railway net, the most frequented waterways, and the largest ports of the continent. But, lacking almost entirely natural frontiers, the Netherlands have always been open to cultural and political influences on their borders, and hence no dominating centre has been able to establish itself and gain control over the whole area. The author deals,

in an interesting chapter, with the striving of modern Belgium towards a common cultural outlook and expression, and the difficulties—historical, ethnic, religious, and political—that have stood in the way.

Although the author is interested mainly in the dynamic aspect of his subject, and stresses developments and trends rather than actual conditions, there is much valuable information for the student who is anxious to fill out his mental picture of the land and its activities. On the economic side the analysis and description are perhaps a little meagre; the author confines himself to generalizations. The reader will have to go elsewhere for an adequate account of the port of Antwerp in relation to its hinterland, for example, or for the physical conditions underlying the exploitation of the coalfield.

Not the least interesting part of the book is supplied by the maps, particularly those dealing with the great changes in the distribution of land and water caused, in the last few centuries, by Nature and Man. H. O.

DER RHEIN. By KARL HAUSHOFER and others. *Berlin: Kurt Vowinckel* 1931. Erster Band: Zweites Buch: Bodenwerke und Wegsamkeit (II. Teil) [together with] Drittes Buch: Leben und Raum. 10×7 *inches; 352 pages; maps. M.30*

This work consists of seven papers by different authors. Dr. K. G. Schmidt writes on Soils and Surface Deposits. This section is a masterpiece of summarizing and leaves a clear picture of the region in one's mind. The section on reclamation of moorland is of particular interest to any one who has considered the same problem in Scotland, and his analysis of soils is concise and clear. An extensive bibliography follows. The writers are mainly German, but one is glad to note a reference to Mr. J. O. Borley's work on marine deposits in the southern North Sea.

The Geography of Traffic, by Dr. O. Maull, of Graz University, comes next. This opens with a short paragraph on the cultural landscape and then the geomorphology of the natural routes is rapidly sketched, as this has had fuller treatment in Book I. The author goes on to trace the history of routes and illustrates his work by an extremely interesting series of small maps. The increasing importance of the east, with its great mediaeval centres at Augsburg, Nürnberg, Erfurt, Cassel, Frankfurt, etc., is brought out by a comparison of the maps showing Roman and mediaeval roads. Railway, modern road, and canal traffic all receive attention. The author considers the French and Swiss scheme for the Grand Canal d'Alsace, and comes to the conclusion that in developing her traffic to the sea by this route Switzerland shows a short-sighted policy, as the Rhine is her true outlet. The diagrams of trade which follow are worked out in what is to the reviewer a new system, and one which shows very clearly changes which have taken place for the years given before and after the War.

Book III opens with a paper on plant life by Professor Karl Troll, of Berlin University, and Dr. H. Gams, of the Mooslachen Biological Station. Section II, which deals with cultivated plants, is perhaps the most interesting for the geographer who is not also a botanist. The maps are small, but clear and useful, and again a very comprehensive bibliography is provided. Animal Geography, by Professor F. Zschokle, of Basle University, has a most valuable section dealing with the fisheries. The changes taking place as a result of man's occupation of the region are clearly brought out. There is a charming paragraph on bird flight and the movement of fish which are used with great skill in giving a bird's-eye view of the whole Rhine region. The chapter on sites for settlement is contributed by Professor Krebs, of Berlin University. He traces the historical development of the many old towns in which the region is so rich. This and the following section on landscape and settlement of the present by Professor H.

Schmitthenner, of Leipzig University, are in some ways the most valuable. They owe much to detailed field work by many workers—a debt acknowledged in the list of authorities appended to the sections; but it is difficult in a short review to do justice to their scope. Dr. Schmitthenner's section is full of delightful detail. He treats fully the form of village and town, and this is of great interest and value to geographers studying similar phenomena in our own country and to those engaged in town planning. One is glad to learn that the house in the Black Forest, so beautifully adapted to the region and the work carried on there, is relatively modern. The relation between style and building material receives attention, and there is an interesting discussion on the slope of the roof. Professor Schmitthenner seems surprised at finding the steeply pitched roof on the sea-coast, but it is common on our own wet west coast in North Scotland at any rate, and the late Professor Brunhes has suggested that the flattened roof found in the high Alps is designed to retain the protection of the winter snow—another roof which surprises the author. His treatment of industrial towns leads one to turn with fresh interest to the problem of industrial centres in Great Britain.

The form of the work makes some repetition inevitable. But the whole volume is a very valuable attempt to combine many regional and laboratory studies in a study of some great natural feature, in this case the Rhine, which gives unity to widely differing areas. It is not a method which could be applied to all river basins, but some use could be very advantageously made of it in combining regional studies in other countries, and one is grateful to the authors for the inspiration as well as the matter of their work. G. M.

ASIA

SURVEY OF INDIA. GEODETIC REPORTS. Vol. IV. From October 1927 to September 1928. xii+146 *pages*. Vol. V. From October 1928 to September 1929. xiv+156 *pages*. Vol. VI. From October 1929 to September 1930. xii+106+lxxiv *pages*. *Dehra Dun: Survey of India* 1929, 1930, 1931. 10×6½ *inches; diagrams and maps*. *Rs*.3 (5*s* 3*d*) *each*

The volumes under review worthily uphold the traditions of the Survey of India both as a record of industry and as a vehicle for the publication of research work. A word of commendation must be given to this particular method of publication in summarized general reports, not too discursive on any subject but yet detailed enough to be of value to fellow-workers in the same field.

Triangulation has taken place during the three years on the North-West Frontier and on the Burmese boundary, the latter primary and the former secondary. The use of the Wild theodolite enabled triangulation, otherwise almost impossible, to be carried out in a hostile or inaccessible region. In geodetic triangulation its performance equals that of much larger theodolites of older type and ensures speed. A defect in the lubrication of the vertical axis, leading to stiffening, has given trouble in early instruments, but is believed to have been overcome in later models. Apart from the intrinsic advantages of lightness combined with precision the reaction of an observer to such an instrument is likely to make him turn out good work.

The junction of the Great Salween Series with the Siamese Meridional Arc would have been completed but for some ill luck. When it is finished there will be two great arcs of meridian 1000 miles long, from 1° to 3° apart in longitude, connected by cross links at 14°, 20°, and 24° latitude, and to be further connected at 11° and 16°. Nor is this all, for the triangulation of Malaya, an oblique arc 400 miles long, is about to be connected with the great arc of Siam.

Tidal work continues in India although a certain number of stations with

automatic tide gauges were closed a few years ago. There are now seven such stations. Tidal Predictions have been published in a new form of greatly increased scope, entitled "Tide Tables for the Indian Ocean." The volume includes predictions for 68 standard ports, harmonic constants for 169 ports, and tidal differences for 465 ports. It is sold for Rs.3.

Observatory work of considerable interest is carried on. A programme of observations for Variation of Latitude has been commenced with a Cooke zenith telescope. Bi-weekly observations for longitude continue with the bent transit instrument. The results of these show rather large day-to-day fluctuations mounting, in the last year under review, to about $\pm 0{\cdot}1$s at the worst, and showing also occasional differences of about half this amount between the values derived from the same transit observations, but from different wireless time signals—Bordeaux 08h 01m and Rugby 09h 55m. The long time intervals which have to be carried by the clock may account for some of the anomalies. The recently acquired Shortt Clock and the improved constant temperature cell for it should diminish the fluctuations. Another useful development at headquarters is the Hunter Short Base designed by Dr. De Graaff Hunter for topographical purposes. It consists of four sections of steel tape (or Invar if the accuracy be required and the expense justified) supported by two terminal and three intermediate posts.

A considerable amount of Precise Levelling has been carried on during the three years, and chief interest attaches to changes of level detected and to particular problems of levelling attacked. In one case (Ambala, Punjab) a regional sinking of 2 inches over eighteen years followed a sinking of 7 inches over the previous fifty years, but the cause was considered to be dewatering by wells rather than an earth movement. Levelling over wide rivers has been systematically investigated. The best method is, as one would expect, to set up an instrument on an island in midstream and two others on the banks. It may even be worth while sinking a special stage in shallow water to procure this end. Unsatisfactory results of levelling in the hills have been traced to the behaviour of wooden staves, which are now being replaced by Invar staves. Diurnal changes of length in wooden staves apart from purely temperature changes are apt to give bad results and the frequent checking of the lengths may fail to detect the changes.

The Survey of India has been long noted for its pendulum work. Between September 1927 and September 1930 no less than 58 stations were occupied—9 near the North-West Frontier, 8 near Karachi, 21 on the central Indian plateau, and the remaining 20 mostly on the East Coast or in Southern India. The old tragedy has been enacted in India as in most other parts of the world. Valuable pendulum observations have had to be rejected because the flexure of the support was unknown. All the famous observations of Basevi and Heaviside, and indeed all Indian observations up to 1904, have suffered this fate. It is interesting to note that those made at Calcutta in 1904 had to be rejected on account of the motion of the ground itself. Upon the introduction by Dr. Vening Meinesz in 1923 of the synchronized twin pendulum apparatus, with a third and similar freely hanging pendulum to obviate the effects of movement in the floor itself, Sir Gerald Lenox Conyngham, Reader in Geodesy at Cambridge and formerly Superintendent of the Survey of India, designed a new apparatus on these lines and established a subsidiary base at Cambridge. Every country adhering to the International Geodetic Union is now provided with a so-called National Gravity Station. The Indian and the British are, respectively, Dehra Dun and Greenwich. India has followed suit in obtaining a Cambridge Pendulum apparatus, but both there and in Great Britain the three-pendulum arrangement has been discarded for general use since the ground is rarely unstable enough to require it. The twin pendulums, perfectly synchronized and swinging in opposi-

tion, are the essential feature, and the School of Geodesy at Cambridge has taken advantage of this to have a smaller and much lighter chamber constructed of aluminium alloy to take two pendulums only.

The study of gravity data becomes more interesting if it is pushed beyond a mere statement of the anomalies with reference to an empirical formula, coupled with another set of anomalies based on the Isostatic Theory. The application of the latter theory in a numerical form laid down as a result of researches in one part of the world may be erroneous in other regions, as for instance in continental India. Dr. De Graaff Hunter's work on the geoid in India, contained in these and earlier publications of the Survey of India, is distinguished by breadth of outlook and is rendered lucid by excellent series of diagrams. The problem of determining the best figure of the Earth is not now in the forefront of geodetic investigation. It is known that different figures fit different regions—in other words, that the centre of interest is not the spheroid but the geoid and its irregularities. Although the adoption of an International Spheroid of Reference was admittedly a matter of expediency there has perhaps been a little too much of the underlying thought that any one extensive portion of the geoid, when treated in accordance with a special form of the Isostatic Theory, would yield *the* Spheroid.

Meanwhile what is required is a closer correlation between the approaches to the problem *via* the deviation of the vertical on the one hand and pendulum work on the other. In this interesting field the Survey of India is active. Attempts have recently been made to correlate g with local density anomaly by two distinct methods. Major Glennie finds a linear relationship between isostatic gravity anomalies and the raising of the geoid. He proposes therefore to seek for strictly local anomalies by means of the formula $g-\gamma_D$, where $\gamma_D=\gamma_c+KH$ and where γ_c is the theoretical gravity corrected for topography on the Hayford basis, and H is the raising of the geoid as found from the extensive data on the deflexion of the vertical. Captain Bomford uses the same data for the geoid but computes the simplest crustal anomalies which are competent to explain it. This solution rests on broader hypotheses as to compensation than the restricted Hayford form, and from it gravity values may be computed. The differences between these and the observed values may be expected to reveal local anomalies of density. Dr. De Graaff Hunter contributes a useful theoretical discussion of the whole question and also examines the question of gravity formulae in general. Each volume closes with a list of publications of the Survey of India, and Volume VI has, in addition, complete lists of Deflexions of the Vertical and of modern gravity values for India and adjacent areas. It is to be hoped that these Geodetic Reports will be widely read. They constitute an excellent tonic for the geodesist of the more hide-bound type. H. L. P. J.

A REFUGE FROM CIVILIZATION, AND OTHER TRIFLES. By R. JONES-BATEMAN. *London: Edward Arnold & Co.* 1931. $7\frac{1}{2}\times5$ *inches;* 192 *pages; illustrations and sketch-map.* 6*s*

The junior Civil Servant whose office it is to maintain contact between rulers and ruled in the outlying districts of our tropic Empire is fortunate if he brings to the solace of his term of exile a quick sense of humour and an appreciation of the social complexities surrounding him; more fortunate still if to the above is added the gift of apt and convincing utterance. That Mr. Jones-Bateman possesses all these qualities this book is clear and charming evidence. Posted to the charge of the least important of the many districts into which the island of Ceylon is now divided, with a mere remnant of a population occupying odd corners of what were once the outlying lands of a highly civilized kingdom that

vanished ages ago; cut off from every convenience of modern life and condemned to the daily service of the trivial affairs of a poverty-stricken and ignorant peasantry, Mr. Jones-Bateman is nevertheless far from boredom. With discerning eye and abiding sympathy he recognizes his fellow-man in the humble Tamil and Sinhalese villager, and finds in their virtues and failings a constant interest to beguile seclusion from his kind, and a source of pleasure for all those who read these tales of the Wanni and observations on the morals and mentality of its simple people.

Though the object of the author is solely to amuse, and even his moralizings savour of burlesque, the innate kindliness and honesty and the ludicrous efforts at guile of the Sinhalese peasant mind shine through the book, lit by the sparkling facets of his humour. The closing chapters, "The Chronicles of U—," are sheer frolic. W. A. G.

A WANDERER IN INDO-CHINA: the chronicle of a journey through Annam, Tong-King, Laos, and Cambodgia, with some account of their people. By HERMANN NORDEN. *London: H. F. & G. Witherby* 1931. 9×5½ *inches;* 290 *pages; illustrations and map.* 15*s*

In the opening chapter of this book a brief history is given of the circumstances in which Cochin-China became a French colony and the extension of French influence to Annam, Cambodgia, and a part of Laos; and the writer gives throughout a glowing account of the relations existing between the French officials and the various tribes and communities he visited whose affairs are administered by them. An experienced traveller who chooses to travel by car rather than by rail and apparently prefers a river trip to either when it can be had, Mr. Norden had great opportunities to study the different peoples, their manners, customs, and folk-lore; and he gives an interesting collection of stories and legends. Among these is the pathetic history of the last days of the Champa kingdom and the Annamite conquest which followed on the destruction by the Champa king himself of the tree by which the kingdom was protected. At the halts on his journey the author stayed as a rule with French officials and heard from them illustrations of the curious forms of superstition still in existence. At Hagiang, for example, shortly before his arrival the Man chief of a village had eaten the brain and tongue of a captured bandit in order to possess himself of the robber's strength and courage.

Of all the peoples described, the Laotians are perhaps the most interesting: the inhabitants of "the land of love and song," as Laos was described to the writer by a French resident. But the "remark of many" has also to be chronicled with regret, that "a Laotian is all right provided you don't ask him to work!" The author ends his circuit of Indo-China in Cambodgia, "that land of rice-fields and jungles, and cities which were abandoned and found again after long centuries." He devotes the last chapter to an account of the discoveries which were "no surprise to the Cambodgians," whose folk-tales are full of references to hidden cities and who "are believed always to have made pilgrimages to old abandoned shrines in the jungle." A useful map showing the route taken and excellent photographs make the writer's journeys more intelligible to readers who are not acquainted with Indo-China. W. G. G.

ARABIA FELIX: across the empty quarter of Arabia. By BERTRAM THOMAS. *London: Jonathan Cape* 1932. 9½×6½ *inches;* xxx+396 *pages; illustrations and map.* 25*s*

It is not the intention of the writer of these few lines to review Mr. Thomas's 'Arabia Felix' from the point of view of its geographical importance, nor to write

of the various kindred subjects which are so faithfully dealt with. That will follow. But it is possible that in the many reviews which have been made few have quite realized how intense is the intimacy which Mr. Thomas has had with life in Southern and Eastern Arabia, and with what absolute reality he discloses it to his readers. To those who know the East, the scenes and conversations must provide an explanation of many an Arab action. To those who do not know the East an incentive is provided to learn.

Nothing of the code of desert life and honour is omitted; the desire for fatherhood, especially of a male child: the intricate reasoning of mine and thine which governs desert polity: tribal loyalties: the acceptance of the all-pervading, ultimate and absolute decree of Allah, one and indivisible in the conduct of the world, making, it is true, little difference in their own; all this is displayed in a manner most remarkable. The very stories, translated without losing their Eastern character, disclose the mind of the Badu in a way seldom before presented.

It is understood that Mr. Thomas has in view the spending of some time in what he terms a serious contribution to the study of Arab life and character. If 'Arabia Felix' is an example we look forward with eagerness to the results.

W. E. G.

SIAMESE STATE CEREMONIES. By H. G. Quaritch Wales. *London: Bernard Quaritch* 1931. 10×6½ *inches;* xiv+326 *pages; illustrations.* 25*s*

Before Siam came into contact with the outside world and found herself constrained to adopt modern ways, religious ceremonial formed the principal occupation in the lives of her people, the peasantry finding ample time for their ever-recurring festivals between the brief periods of their agricultural labours; while the satellites of the Court, the only other class in the land, existed for little else than attendance upon the king in the performance of the splendid and complicated rites ordained for the royal observance practically all through the year.

Recent developments have turned the public attention to more worldly objects, while the court satellites have given place to an earnest and industrious official class, and while the influence of the religion and the monarchy are still great, there appears a tendency to ensue fortune, both private and public, more in the profane paths of modern politics than in the propitiations and pomps of tradition. Hence this excellent work comes at a time when, apart altogether from its very considerable value for all students of Oriental culture, it may, as the author repeatedly remarks, prove of special service to Siam by impressing upon her youthful modernists the significance of her national faith and kingly tradition, and the fact that at the present stage of her mental and social development it is in the careful cherishing of these institutions rather than in democratic experiment that she is most likely to find security.

His association with the Lord Chamberlain's Department in Bangkok enabled Mr. Wales to see much of the Royal Ceremonial, more especially as during his time in Siam there occurred a demise of the Crown, a Royal Cremation, an Accession, and a Coronation. Assiduous observation of these and other ceremonies and much reading have furnished the material for this notable compilation. Contributions have been freely drawn from Siamese records, ancient and modern, from Indian historical and mythological works, and from writings of Europeans from the sixteenth century onwards, and these the author has skilfully fused with a medium of facts personally noted and theories deduced therefrom into a thoughtful and scholarly treatise, probably the most comprehensive hitherto produced on this engrossing subject. The author sets out his argument, traces the origins of Siamese religious culture and ceremonial, chiefly Hindu, and gives an epitome of social organization. Hinayanist Buddhism is the national

religion, but the State Ceremonies are Brahmanic with, here and there, Buddhist permeations. It is with these last that the author is concerned, only one of the numerous purely Buddhist ceremonies being examined. The rites fall into two categories, one personal to the king, and the other affecting matters more actually of public import, in which agriculture has first place. The Kingship, strange mingling of humanity, Buddhist Sanctity, and Hindu Divinity; the mystic prohibitions that hedge it about and the Brahman priests who minister to it, are minutely considered and described, as are the sacred rites that accompany Royalty with courtly solemnity and magnificence through every stage of life. The ceremonies connected with agriculture, some intimately, others remotely, are dealt with, investigations into *Loh Ching Cha*, "The Swing Festival," and *Rek Na*, "The First Ploughing," being notably full. Rites connected with the White Elephants, propitiations of guardian spirits, and exorcism of evil occupy the latter part of the book, and a few pages of general conclusions end it. The transliteration of Siamese into European characters presents many difficulties. The author has adopted the scientific system employed for the transliteration of Sanskrit which, though possibly inconvenient for readers knowing Siamese but ignorant of Sanskrit, needs no apology in a work of this nature. Mr. Wales's literary aptitude lends additional pleasure to the study of his book. It is well illustrated from photographs and has a serviceable index. W. A. G.

AFRICA

THE AFRICAN REPUBLIC OF LIBERIA and the Belgian Congo. Edited by RICHARD P. STRONG. *Cambridge (Mass.): Harvard University Press (London: Humphrey Milford)* 1930. Two vols. 11×7 *inches;* Vol. I, xxvi+568 *pages;* Vol. II, x+569–1064 *pages; illustrations and maps.* $15

These two handsome and profusely illustrated volumes are based upon observations made and materials collected during the Harvard African Expedition (1926–1927). Although the chief object of the expedition was the making of a biographical and medical survey of Liberia "which apparently was" (at that time) "that country of Africa about which least was known in those respects," the party of explorers crossed the continent from west to east and made comparative studies, especially in the Belgian Congo. The personnel of the expedition, besides the leader, Dr. Strong, consisted of eight experts in Tropical Medicine, Entomology, Botany, Zoology, and Photography. The first volume contains a detailed and well-illustrated account of the various native tribes, their customs, beliefs, and languages. Native medicine is described in some fullness. There is an interesting account of the "leopardmen," who kill and eat their victims after ambushing them in the guise of a leopard. Every aspect of the Government administration and of the financial and economic condition of the land is dealt with. There are some beautifully illustrated chapters on the flora and fauna. More than half of this volume is occupied by a very useful and full account of the diseases of Liberia, and of the Belgian Congo. Probably there is not another part of Africa about which a corresponding account has ever been written. It is a curious anomaly that for this black and rather inaccessible Republic we should possess such a fine and well-collected body of knowledge. There do not however appear to be any startling discoveries. There are many beautiful microphotographs of sections of diseased tissues, very good but not specially original.

In Vol. II the account of the insects of medical importance is really very useful The author, M. Bequaert, is a first-rate man. He has not only collected a great deal of material but has also read up the African side of his subject and incorporated much general information in his text. Possibly this valuable material

might better have been published separately in the appropriate scientific journals. The Report as a whole however supplies the fullest and most up-to-date information about a part of Africa never before so fully investigated, and it is essential to the traveller or scientist who would know about this strange negro state.

E. W. G. M.

THE AFRICAN HANDBOOK AND TRAVELLER'S GUIDE. Edited by OTTO MARTENS and O. KARSTEDT. *London: George Allen & Unwin* 1932. 7×4 *inches;* xvi+820 *pages; maps and plans.* 10*s* 6*d*

This up-to-date handbook, translated from the German into excellent English, was written for the German African Shipping Lines and deals mainly with those parts of Africa which are served directly by German lines. Thus nearly 800 pages are devoted to the lands which lie south of lat. 20° N.—that is, to all except Abyssinia, the three Somalilands, and Eritrea, for which countries, together with Egypt, French, Italian, and Spanish North Africa, and several islands, only twenty-one pages of an appendix are left! The parts however which are described are usefully dealt with, and it is stated that the editors enjoyed the active collaboration of the various African governments concerned and their European representatives.

Valuable information, often in tabular form, is given under two headings, "General" and "Travel," so that the volume is not only a help to travellers, but "a guide to the geographical, climatic, economic, and traffic conditions of the various African countries" as well as to history, agriculture, customs, administration, fauna, education, etc.

The Travel sections, while starting with German home towns, describe all places touched at by German ships on the outward and homeward voyages, the best-known towns and districts in East, South, West and Central Africa, and practically all the routes along what in the last few years has become the beaten track. For example, the full itineraries with intermediate distances are given for journeys from Cairo to Nairobi, and from Nairobi to Capetown, and with less detail from Nairobi to Lagos in Nigeria, also time-tables of air services operating in many parts of the continent.

The Travel section in West Africa is of necessity short, and will probably be less often required, though distances and rates are given on the Benguella Railway and on several others, besides the chief roads in French West Africa, and a note on the winter motor service from Algeria to the Niger.

There are however unexpected omissions. For instance, no information is given about Lake Kivu and its western shores, which have been so much opened up in recent years by Belgian administration not only for colonists but for travellers. The maps, some of which are said never to have been published before, are clear, and the index adequate.

E. W. N.

NORTH AMERICA

FRESHWATER: a history and a narrative of the Great Lakes. By GEORGE A. CUTHBERTSON. *Toronto: The Macmillan Company of Canada* (*London: Macmillan & Co.*) 1931. 9½×6 *inches;* 316 *pages; illustrations.* 36*s*

Mr. Cuthbertson, who served in the Navy during the War, has compiled a most interesting account of the history of shipping on the Great Lakes from the earliest times to the present day. Although he has made full use of the studies of Grant, Cruikshank, Mahan, Roosevelt, and others, his enthusiasm for the subject has enabled him to supplement their researches by his own investigations. The excellent illustrations add greatly to the reader's enjoyment.

Champlain knew perfectly well in 1615 that he could reach Quebec from Lake Ontario by way of the St. Lawrence, but was unable to obtain a canoe from his Huron hosts. Mr. Cuthbertson might have quoted Champlain's own description of the canoes used in his time which seem to have been longer than is stated. We have an excellent account of the construction of the *Griffin*, but it is strange that the author nowhere refers to the detailed account thereof drawn up by the late J. G. Shea. The story of the struggle on the Lakes during the Seven Years' War is also well told, but the *Victort*, mentioned on pp. 91–92, is surely intended for the *St. Victor*, which is mentioned by Montcalm. There are several slips in the French names of vessels and places: *Le Generale* should be either *Le Général* or *La Générale*, and *Outard* and *Point au Pines* are incorrect French.

The story of the War of 1812 is told with great vividness and accuracy due not only to the care with which Mr. Cuthbertson has done his work but also to the excellent illustrations of the ships mentioned. The author gives a mass of technical details regarding the construction of these ships with full particulars of their build and rigging. Mr. Cuthbertson is remarkably fair in allotting praise or blame to the leaders of the fleets at this period, and his own experience in the Great War has enabled him to appreciate fully the difficulties which had to be overcome on both sides in that struggle. He brings his most interesting volume to a close with a rapid survey of the great fleets of the modern steamship companies now operating on these lakes.

There is a good index, but the bibliography is full of misprints: Heefer should be Keefer, Cobley Colby, Wildon Willson, and Batterfield Butterfield. But Mr. Cuthbertson's own account is so complete that few of his readers will need to refer to the works listed in the appendix.

It is to be hoped that appreciation of the value of this volume will encourage the author to complete his work on the vessels which traded between France and Canada during the French régime. H. P. B.

CENTRAL AND SOUTH AMERICA

ANCIENT CIVILIZATIONS OF THE ANDES. By PHILIP AINSWORTH MEANS. *New York and London: Charles Scribner's Sons* 1931. 10×7 *inches;* xviii+586 *pages; illustrations and sketch-maps.* 30*s*

Mr. Means has produced a remarkable work and one which will prove of great use to all students of the area. It deals with the History, Archaeology, and Sociology of what he calls the Civilizations of the Andes, tracing them from the earliest period, called by him "Archaic and Migratory," to the time of the arrival of the Spaniards. The author has consulted a large number of works in different languages, many of the authorities quoted being very difficult of access to the general reader, and has thus produced what is probably the most complete account in English of the rise and fall of the various cultures. The conflicting stories of the rise and subsequent history of the Inca Empire are given very fully.

There are two excellent chapters dealing with the Economic, Governmental, and Social Aspects of Incaic Civilization, and the Ceremonial Life and Official Religion of the Incaic State. The subject of weaving is very fully treated. It is a great pity the word "archaic" has such an unfortunate fascination for Mr. Means. He uses it repeatedly and seems not to understand the meaning of the word nor to realize that because something is crudely made it is not necessarily more archaic or more ancient than something more highly finished. The term "archaic man" could be much better expressed by the more usual "primitive man." Mr. Means does not believe the new world owes any of its culture to the

old, and holds the theory "of the wholly American origin of all the New World Cultures and, more especially, of the New World Civilizations." L. C. G. C.

AUSTRALASIA AND PACIFIC

GREAT DIPPER TO SOUTHERN CROSS. By EDWARD H. DODD, Jr. *London: Arrowsmith* [N.D.]. 9×6 *inches;* xii+332 *pages; illustrations and sketch-map.* 15*s*

Under this title is contained the description, by an American writer, of a year's cruise in a 70-foot schooner yacht through the tropical islands of the South Seas. The voyage constituted a not inconsiderable feat in view of the size of the ship, the number of the crew (five), and the treacherous latitudes through which they sailed. That it was accomplished without any mishap to vessel or crew reflects some credit on the skill with which the ship was handled and the courage, judgment, and resource with which each vicissitude was faced as it arose.

The main purpose (apart from pleasure) of the cruise was the investigation of the various groups of islands. While it is probably true that little of special importance in the way of additional knowledge or discovery is to be gained from the experiences of the writer and his friends on their visits to the different islands, yet Mr. Dodd's descriptions of the appearance, manners, and modes of life of the islanders are of considerable interest. In their expeditions into the interior of the islands the party of young Americans made many acquaintances, to whom the author introduces us with much lively description and detail. He presents to us also clearly drawn pictures of the different islands and their distinctive features, commenting upon the surprising racial differences existing between the inhabitants of islands belonging to the same group: language, arts, customs, and occupations differing noticeably one from another.

One of the most attractive features of the book is supplied by the delightful descriptions of sea and sky as seen from the deck of the *Chance*. The author's appreciation of the beauty of these effects and his evident response to the mysterious charm of the South Sea Islands inspires in the reader a similar enthusiasm, and lends colour and romance to his story of the cruise. The book makes very pleasant reading, especially to travellers and lovers of the sea, and the illustrations are excellent. W. G. G.

POLAR REGIONS

SOUTH GEORGIA: THE BRITISH EMPIRE'S SUBANTARCTIC Outpost. By L. HARRISON MATTHEWS. *Bristol: John Wright & Sons* (*London: Simpkin Marshall*) 1931. 9½×6½ *inches;* xii+164 *pages; illustrations and sketch-maps.* 15*s*

Apart from passing references in travel books there has been no general description of South Georgia available for English readers, and Mr. Matthews's history of the island is very welcome on that account. The author was employed by the Discovery Committee on whaling research at Grytviken Harbour for two years, and his narrative is based partly on his personal experience on the island and partly on a close comparative study of the early voyages.

The main part of the book is historical. Vespucci's possible visit in 1502 is treated with caution. The first undoubted sighting of the island appears to have been that of the London merchant La Roché in 1675; he was supposed to have sailed round the north end of the island, but Mr. Matthews's close acquaintance with the ground enables him to decide that La Roché's track was almost certainly

round the south. Succeeding voyages are each treated in detail, and quotations, some of them of considerable length, are made from the accounts of the different voyages, and where more than one narrative is available all are quoted in turn. As a history of the island the book is extremely interesting and useful, and of course gains very much by reason of the author's intimate local knowledge. Of the various chapters, one describes the old-time sealing at the beginning of the nineteenth century, and another the modern whaling methods inaugurated in 1904. There is also an interesting account of the animal life, and particularly the bird life, on the island, on which Mr. Matthews writes with authority. The pages relating to the geology are more slender and are unfortunately based on an early investigation now considered incorrect. Apart from this the book is very carefully compiled, and the numerous photographs, drawings, and sketch-maps are excellent. J. M. W.

CARTOGRAPHY

AN INTRODUCTION TO THE MATHEMATICS OF MAP PROJECTIONS. By R. K. MELLUISH. *Cambridge: University Press* 1931. $9 \times 5\frac{1}{2}$ *inches;* viii + 144 *pages; diagrams.* 8*s* 6*d*

This very interesting book is named precisely: it is an introduction, not a complete treatise, and it is strictly limited to the mathematical theory as distinct from the computation. It assumes the right mathematical equipment in the reader, and makes no concession to weaknesses; it does not, for example, anywhere indicate how to prepare one of the expansions in series for numerical calculation. It began as a "mathematical essay on maps written at Cambridge in 1922," written without any wide acquaintance with actual maps or with the literature of their projections. It took a very general view of the subject, with the familiar projections as details in the landscape; it treated the spheroid rather than the sphere, and cheerfully expanded most of the formulae to a few terms without considering the numerical values of those neglected. The author was then introduced to the work of the late Mr. A. E. Young, published as the first number of our Technical Series, and he developed his own ideas very much under the influence of that original and rather difficult treatment. Mr. Melluish's book is an excellent commentary on the intricacies of minimum error projection, inspiring the hope that some day a resolute computer will calculate some examples and show how much it all means in practice. The author then tackles Tissot's theory of the Indicatrix, without finding much in what has always seemed to the reviewer a barren field; after that the errors of finite representation, loxodromes, and geodesics on different projections, and other recondite subjects. The last chapter discusses from the point of view of the mathematician the best projection for a given country, starting with the ideas of Tissot, and arriving at the very recent work of Laborde, reviewed by Young in the *Journal* for October 1930.

It is most useful to have this essay on the mathematics of map projections. The subject is very active at the moment. We are awaiting with lively interest the promised treatise of Driencourt and Laborde. We have yet to learn how much there may be in the papers left by the late Mr. Young. Meanwhile the student with sufficient mathematics will gain a broad and philosophical view of the subject by studying this, the only book of its kind in English; and he must not be misled by occasional lapse into common error, such as the statement on p. 7 that the cone on which the conic with two standard parallels may be supposed constructed cuts the Earth in those standard parallels. A. R. H.

ECONOMIC AND HISTORICAL GEOGRAPHY

REGIONAL SURVEY AND ITS RELATION TO STOCKTAKING OF the agricultural and forest resources of the British Empire. By RAY BOURNE. (Oxford Forestry Memoirs, No. 13.) *Oxford: Clarendon Press* 1931. 11×7½ *inches; 170 pages; illustrations.* 15*s*

This memoir of the Oxford Forestry series is of wide interest and of definite value to geographers. The author, now Lecturer in Forest Management in the Imperial Forestry Institute at Oxford, has had long experience in India and Africa to supplement his scientific work in England, and his aim in this book is to show the need for definite planning in the development of agriculture and forestry and to demonstrate a practical method of carrying out the necessary surveys.

He emphasizes the necessity of a basis of accurate and detailed knowledge of local conditions, and tackles the problem of obtaining this information over very wide areas. His suggested method is threefold. The first stage is the recognition of small unit-areas, termed "sites," which lie within larger ones termed "regions." "A site may be defined as an area which appears, for all practical purposes, to provide throughout its extent similar local conditions as to climate, physiography, geology, soil, and adaptive factors in general. While a site may be unique, more often the same type of site is to be met with again and again within some readily identifiable area." To a regional geographer such independent formulation of his general theory by a practical man, and such assistance in its detailed working-out as is given in this memoir, are most encouraging and helpful. As a complete survey of such small areas is generally impossible, the next method advised is that of "sampling," namely along lines so chosen that the chief types are encountered. The third step is the employment of series of air photographs along these lines, enlarged to a scale of about 7 inches to 1 mile, and mounted to form continuous strips.

The author shows how after such photographs have been obtained a relatively rapid ground survey suffices to ascertain the essential character of the local conditions. The specimen area surveyed by these methods was a strip across the Cotswolds, the Oxford Vale, the Chilterns, and the Thames Valley to Bagshot Heath, and in addition to the strip photographs and enlarged views, an appendix gives details of the surface, soil, and farming conditions in the numerous regions traversed. The whole memoir must be strongly recommended to geographers on account both of its general suggestiveness and of the detailed studies of regional types of south-eastern England. J. F. U.

GENERAL

THE APPROACH TO GEOGRAPHY. By E. BOWN. *London: Christophers* [1931]. 7½×5 *inches; 148 pages; diagrams and sketch-maps.* 3*s* 6*d*

This is an interesting book, intended chiefly for students and teachers in kindergartens and preparatory schools. Miss Bown has collected together some suggestive ideas and has compiled a very readable little volume. The problem of teaching geography to the very young must be a difficult one, but the author has shown not only that it can be made interesting to the learner, but that it is also a strenuous and exciting undertaking for the teacher. The book contains many useful hints and also selected examination papers set under the auspices of the National Froebel Union. J. A. S.

THE MONTHLY RECORD

VISIT OF THE KING AND QUEEN

On the afternoon of Saturday March 5 the Society was honoured by the visit of Their Majesties the King and Queen, who were received by the President, Sir Francis Younghusband, Sir Charles Close, and Lord Biddulph. Their Majesties spent an hour and a half in a thorough examination of the new buildings and of the museum and collections of the Society, and before His Majesty left he commanded the President to inform the Fellows that he had been very much interested and wished the Society well in all its efforts. The President was permitted to assure His Majesty that Their Majesties' visit and the great interest which they had shown were a very genuine encouragement to the whole Society.

The President has since received from Their Majesties as a memento of their visit the gift to the Society of a beautiful pair of miniature globes on mahogany stands. The terrestrial globe has a diameter of about $2\frac{3}{4}$ inches and is inscribed "A Correct GLOBE with the new Discoveries," with evident reference to the first voyage of Captain Cook, of which the track is shown. The celestial globe is inscribed "A Correct Globe with y^{e} New Constelations of Dr. Halley, etc."

This very beautiful gift will be placed in the Map Room with the letter in Her Majesty's hand which accompanies it.

FOREIGN SECRETARY

At the Meeting of the Council on March 7 Lord Howard of Penrith was appointed to perform the duties of Foreign Secretary in succession to the late Sir Maurice de Bunsen until the Annual General Meeting of the Society.

THE STRAIT OF ANIAN

The perennial question of the "Strait of Anian," which made its appearance on sixteenth-century maps as separating Asia from America, is once more discussed in a booklet by Dr. George E. Nunn ('Origin of the Strait of Anian Concept,' privately printed, Philadelphia, 1929), whose former work on the geographical conceptions of Columbus was reviewed in the *Journal*, vol. 66, p. 465. Dr. Nunn brings a good deal of ingenuity to bear on the subject, and writes with a full knowledge of the relevant sources, but the later work seems to have less value than the earlier, for the matter is in itself of less importance and is one on which a positive solution is hardly to be looked for. The concise summary of the geographical conceptions of the age following Columbus (particularly in regard to the relations of America to the rest of the world) is of interest, though some of the views expressed are open to question. The theory is put forward that Waldseemüller's big map of 1507 was intended to give two alternative versions of Eastern Asia, one to the right representing the Ptolemaic tradition, with the additions seen in documents like Behaim's Globe, the other to the left, where the new discoveries are set down. The reasons for supposing these regions to be also intended for Eastern Asia are not made clear, and the theory seems inconsistent with the fact that Waldseemüller, by publishing the views of Vespucci, was the very man who first gave currency to the belief that it was a New World that had been found. Again, it is hardly to be accepted that "the Schöner maps [which regarded America as a peninsula of Asia] almost displaced all other conceptions of world-geography for the period 1523–1560."

Mr. Nunn holds that even the official Spanish maps "were not in conflict with the Schöner concept," calling as evidence the so-called Cabot map of 1544 which vaguely showed a "Terra Incognita" in the position of the North Pacific. This citation is unfortunate, seeing that recent authorities deny that Cabot had anything to do with that map, and it cannot anyhow be regarded as a specimen of official Spanish cartography. As to the actual genesis of the Strait of Anian Mr. Nunn follows other commentators in ascribing it to a misunderstanding or corruption of Polo's names Anin, Cheinan, Quian, etc., but he goes further than his predecessors in trying to explain in detail the causes which led the names in question to be shifted to the far north-east. His explanations may be correct, but in view of the haphazard way in which the map-makers scattered Polo's names over the surface, we may doubt whether any precise conclusions are possible. Like other recent writers he assigns the responsibility for the concept to Gastaldi.

THE FIRST ASCENT OF MOUNT FAIRWEATHER

This fine mountain, which rises to almost the height of Mount Blanc within 20 miles from the sea, has, till the last few years, been singularly neglected by mountaineers, and only last year was its summit successfully reached. The reason no doubt is partly the difficulty of approach and unfavourable climatic conditions, *e.g.* the excessive rainfall, and partly the greater attraction exercised by the still higher Mount St. Elias and its neighbours. In the *Journal* for April 1927 (vol. 69, p. 378) we referred to two partial ascents in 1926 by parties from the United States, neither of which got higher than 9500 feet. This was about the height attained by the first party consisting of Messrs. Ladd, Taylor, and Carpe, who last year returned to the attack with another companion, Terris Moore, who shared with Carpe the honour of the conquest. A short account of their experiences written by Mr. Carpe has appeared in the *Alpine Journal* for November 1931. Bad weather was a constant obstacle, the fine intervals, though glorious in themselves, never lasting long at a time, the more usual experiences being gales and heavy snowfalls. At the outset heavy seas made landing difficult, and quite impracticable at Sea Otter Bight, the landing-place in 1926, so that Lituya Bay, farther down the coast, had to be adopted in the end. Once landed, the stores had to be carried through the forest-belt, and over what is described as a "vile" thicket of alders and scrub, growing on loose surface debris underlain by ice. The glacier reached, a constant drizzle obscured the view ahead, but a camp was formed at 5000 feet beneath the south face of the mountain, whence the party climbed a secondary rib descending from the summit and pitched a second camp at 9000 feet. Here the slope was so steep that space for the one tent was found with difficulty. The spot overlooked a gorge 2000 feet deep into which one of the packs was carried by the gale, though ultimately recovered. Higher up step-cutting up a steep ice-wall was necessary, and, bad weather continuing, the first two attempts failed. The two elder members then decided to turn back, as the stores were getting low, while the two others stayed on to try a final dash, which proved successful. The weather at the top was clear, windy, and bitterly cold, but a splendid view was gained of the coast and neighbouring mountains, including St. Elias. The descent was trying and dangerous, as sun and rain had melted the snow, opening old hard ice at the steepest points, and water stood on the tent floor. During the ascent altitude effects were felt by some of the party, and Mr. Carpe remarks that in all his Alaskan climbs he has found the pressure decidedly lower than the normal for the altitude reached.

The achievement is a notable one, and credit is given to Dr. Ladd especially for the admirable organization of supplies which made it possible.

THE VOLCANIC ORIGIN OF THE BERMUDAS

For some years Mr. R. W. Sayles has made a close study of Bermuda, and his results have just been published in the *Proc. Am. Acad. Arts and Sciences*, 66, 381–467. In 1912 volcanic materials were found by boring at 245 feet and basaltic lavas at 560 feet below sea-level. On the top of these eolian limestones appeared to form the present islands. The close study of this "eolianite" ("consolidated sedimentary rocks which have been deposited by the wind") is the subject of the present memoir. Five strata of this material are described, being separated from one another by layers of soil in which fossil shells are abundant. In addition there are between the lowest strata of eolianite two limestone deposits consisting of marine shells with a few corals in one. Careful calculations are made as to the rate of accumulation of the soil, most of which consists mainly of the insoluble residue of large amounts of eolianite. From this it appears that on a plain a foot of soil might be expected to be provided by the decay of 100 feet of eolianite in about 60,000 years.

On this class of data certain conclusions are substantiated. The Bermuda volcanoes by the end of the tertiary were reduced to submarine platforms. With the coming of the pleistocene the strand line fell to 260 feet below present sea-level by the withdrawal of water to form the continental ice-sheets. The former banks, now plains, covered by shell and other loose material, unprotected by vegetation, were exposed to heavy winds, and dried sands were piled up in great dunes. When the sea-level rose at the close of each glacial stage the source of supply for the dunes was buried beneath the waves. Soil commenced to form, and sooner or later a flora anchored the dunes. Then glacial conditions recurred, the whole series of alternating glacial and interglacial periods being traced in correlation with the glaciations of the neighbouring continent. The present islands were completed by the dunes of the Wisconsin stage, since when there has been some erosion and a very recent formation of an emerged bench due to a 12-foot drop in sea-level. The corals that now grow on the top of the Bermuda bank are clearly a mere veneer, having had no influence on the formation of the bank beneath. J. S. G.

FALL OF SEA-LEVEL IN THE MALAY ARCHIPELAGO

The possibility that a general fall of sea-level has taken place in fairly recent times has attracted a good deal of attention since the subject was discussed some dozen years ago by Professor R. A. Daly in the *Geological Magazine* for June 1920 (see *Journal*, vol. 57, p. 66); and various writers have brought forward evidences of such a fall in particular districts. The January 1932 number of the *Tijdschrift* of the Royal Netherlands Geographical Society contains a paper by Dr. J. van Tuijn, in which a summary is given of various observations in the Dutch East Indies which seem to indicate that a fairly widespread fall of sea-level has taken place there in sub-recent times. It is recognized that in an unstable region like that in question, caution is needed in basing conclusions on what may be purely local phenomena, and therefore attention is directed chiefly to the more western parts of the archipelago, Sumatra, Java, and Borneo, which have not been so much subject to disturbances. The writer brings together quite a number of cases, principally from the first named, in which a recent fall of sea-level is indicated by old sea cliffs 5–10 metres above the present shore-line, while reference is made to the record for Java to be found in Verbeek and Fennema's standard work on the geology of the island. For Borneo, whose relative stability would give especial weight to any such indications, the evidence is much more scanty, though some has been found on the east coast. Its absence on the south and west coasts may be due to the marshy nature of the littoral which would make it difficult to trace the evidence. On the whole the widespread nature of the pheno-

mena seem to argue a general fall of sea-level rather than local tectonic movements. A map showing the localities where the evidence of such changes has been noted accompanies the paper.

THE CLIMATE OF KERGUELEN ISLAND

Meteorological information about Kerguelen in the southern Indian Ocean, about latitude 50° S., has hitherto been limited to fragmentary records of Antarctic expeditions as well as the astronomical missions sent to observe the transit of Venus in 1874. Latterly Mons. E. Aubert de la Rüe has been endeavouring on behalf of the Government of Madagascar to establish more regular observations at Port Jeanne d'Arc, in the south-east of the island, and he gives a useful account of the climate of Kerguelen in the *Revue de Géographie Physique et de Géologie Dynamique* (vol. iv, fasc. 2, 1931).

Kerguelen is described as climatically the Southern Hemisphere analogue of Iceland, which however lies some 15 degrees farther from the equator. The mean annual temperature, about 38° F., is the same in the two islands, but Kerguelen, being smaller and more isolated, has a milder winter and cooler summer than Iceland.

In winter the thermometer usually ranges between 23° and 41° F., in summer between 32° and 50° F., the absolute extremes yet recorded being 14° and 68° F. The seasonal range of temperature is small, but for an oceanic climate the irregular changes from day to day, occasioned by alternations of polar and equatorial air currents circulating in the constant succession of cyclones, are rather pronounced. The weather is damp and tempestuous throughout the year, with precipitation on as many as three hundred days. The violent winds which drive the snow and rain horizontally make the accurate recording of rainfall difficult, but it is estimated that the annual quantity on the eastern or lee side of Kerguelen is about 40 inches, and double that on the exposed western side, where the moisture-laden north-west winds, chilled by the mountain glaciers, produce a heavy snowfall. Snow is not infrequent in summer even at sea-level, and the limit of perpetual snow in February, the warmest month, is found at about the altitude of 2000 feet.

Kerguelen is washed by a cold ocean current which often brings tabular icebergs from the south, but the winter temperature does not fall low enough for the sea to freeze, so that access to the islands is possible at all seasons. Even in clear weather the mountain levels above 3000 feet are nearly always hidden in mist. The icefield, 500 square kilometres in area, known as the Grande Arête de Glace, Mount Richards 4000 feet, and Mount Ross 6000 feet, are rarely visible more than twice a week, and when these glittering summits of ice appear it is said to be a sign of a violent tempest on the morrow.

NAMES ON THE ANTARCTIC CHART

We are informed by the Hydrographer that the Board of Admiralty in agreement with the Colonial Office have approved the adoption of the following names in Admiralty publications:

SCOTIA SEA bounded by a line drawn from Burdwood Bank in 55° W. through the Stag Rocks, South Georgia, South Sandwich Is., South Orkneys, the position 66° S. lat., 55° W. long., and from there along the meridian of 55° W. to the Burdwood Bank.

DRAKE PASSAGE bounded on the north by the latitude of Cape Horn, on the east by the meridian of 55° W. long., and on the south by the South Shetland Is.

WEDDELL SEA is bounded by a line joining the north-eastern extremity of Coats Land to Joinville Island.

ICE FORMATION ON UNFROZEN SURFACES

In a recent brief communication Herr Oskar Gabran, an engineer of Latvia, records some observations made by him on the damp sandy areas of the moorlands of that country. Under conditions where growth by accretion of the moisture of the air would seem to be absent, it is claimed that every autumn ice-crystals up to 10 cms., and in some instances 30 cms., in length can be seen to form, and to accumulate on moist ground-surfaces in considerable masses. The view is confidently put forward that the growth of the ice-crystals definitely takes place from below at the surface of contact with the soil and not by condensation of moisture from the air. It is however only between the limits of temperature of —1° and —1·5° C. for the earth surface and between —2° and —5·5° C. for the air, that the phenomenon has been observed.

In view of the widespread occurrence of this type of ice-crystal formation, which indeed has to be taken into account by farmers in that region, Herr Gabran makes the suggestion that the same process of crystal-growth, resulting in ice formation, may have been largely responsible for the building up from below of the ice-sheets of the Pleistocene Epoch, when presumably the requisite external conditions were perennial. Moreover that existing ice-sheets, such as that of Greenland, where their under portions can be considered to be at a temperature within the limits mentioned above, may mainly owe their continuance to this same process of ice-accretion below. The views of Drygalski and others regarding the existence of the requisite temperature conditions below the Greenland ice-sheet, in its peripheral region especially, are quoted in support of this conclusion. Moreover it is considered by Herr Gabran that could such a process be definitely shown to be operative below ice-sheets in general, it would help to explain the position of the intra-glacial morainic material, which is frequently to be found above the level of the actual ground moraine.

Herr Gabran expresses the opinion that experimental work on a laboratory scale is very desirable in order definitely to prove the competency of this postulated process of ice-formation in the mass; but unfortunately he does not encourage one to believe that he is prepared himself thus to follow up and substantiate the interesting deductions from his initial observations.

Correct though the explanations of ice excrescence forms by growth from below may be, and well known though it undoubtedly be that growing crystals can exert immense pressures, yet in the present state of our knowledge it would seem altogether premature to ascribe such a process of basal accretion to ice-sheets in general both of the past as well as the present. Applied indeed to the Greenland ice-cap, it would appear that only at the borders, and around the nunataks of that region, can the necessary conditions, as deduced from observation, obtain; actually it is not there, where *ex hypothesi* it should be found, that we see the greatest accumulations of ice.

Even if the observations of the recent Wegener Expedition are only approximately correct, it has long been believed by most students of Greenland glaciology that the greatest thickness of ice exists in the central region of that country. And although we are ignorant of the precise nature of the conditions obtaining under the ice-cap, yet they can hardly be assumed to be those considered necessary to produce the kind of crystal-growth described by Herr Gabran: such conditions would there seem to be clearly inhibited. Moreover, has Herr Gabran demonstrated that growth of ice-crystals from below takes place as well on solid rock-surfaces as on the loose soils of his moorlands?

Perhaps the chief point of interest to the writer of this note is the possibility of the application of the postulated process to the formation of polygonal soils in polar and sub-polar regions, and as a factor in their as yet somewhat obscure *modus*

operandi, as well, indeed, as that of various ground-ice occurrences. If further experimentation could be undertaken with this in view, some useful additional data might be forthcoming to assist in the solution of these particular geomorphic problems of polar and certain temperate mountain regions. N. E. O.

EARLY ADVICE TO TRAVELLERS

One of the earliest and rarest of English books on foreign travel is that of Philip Jones, printed by John Woolfe, 1589, a copy of which fetched a high price at the recent sale of Lord Lothian's books at New York. Its title ran: 'Certaine briefe, and Speciall Instructions for Gentlemen, merchants, students, souldiers, marriners, &c. employed in services abrode, or anie way occasioned to conuerse in the kingdomes and gouvernementes of forren Princes.' As the book is not easily accessible it seems worth while to reproduce the following passage (itself taken from a scarce little book by Ortelius, printed in 1584, on his travels in Flanders), both for the sensible advice contained, which is equally applicable to present-day travel, and for the quaint language in which it is couched.

"If in our peregrinations and travels, we shal observe and note in our tables, or papers, those things which doo occur and seeme worthie of regard, we shall make our journies and voyages in great measure pleasant and delectable unto us: not thinking that our diligence can search and mark anything in any place, which other men before us have not seene, but to discourse and recorde anything, rather then to passe the way, and spend the time in idleness: and with all by this meanes, this commoditie is reaped, that whatsoever the eye seeth, is the easier and the better remembred, if it be once written. And when the time cometh, that we make an ende of our travels, and personall view of forren parts, it will be a singular pleasure unto us, whensoever we are so disposed to recognize, and recount those things which we have seen, quietly in our chambers, without any trouble of journie or toile of bodie."

We are indebted to a Fellow of the Society, Col. F. R. Hull, for a transcript of the above passage from the original book.

OBITUARY

SIR MAURICE DE BUNSEN

The Society has sustained a heavy loss through the death, full of years and honours, on Sunday, 21 February 1932, of the late Sir Maurice de Bunsen, who had for eleven years acted as its Foreign Secretary. No more appropriate occupant could have been found for that post than the experienced diplomatist whose public career had familiarized him with the manners and mind of so many nations. Diplomacy was in a sense hereditary in his family, inasmuch as his grandfather, Baron Christian Charles de Bunsen, born in Waldeck some hundred and forty years ago, was Prussian envoy in Rome and subsequently in London, where he married a daughter of George Waddington. His son Ernest de Bunsen, the father of Sir Maurice, also married in England and adopted this country as his home. Another son, George de Bunsen, a man of exceptional gifts and great personal charm, a liberal of the old school, remained in Germany, where, as a representative in Parliament, he was an active and discriminating critic of the Bismarckian regime, foreseeing the danger into which it might lead the German people under less capable direction.

Maurice William Ernest de Bunsen, who was born eighty years ago, in January 1852, was educated at Rugby and at Christ Church, Oxford, where he took his bachelor's degree in 1874. He entered the diplomatic service in 1877 as an attaché, a title with a certain savour of romance surviving from a remoter epoch when envoys abroad were assisted by young gentlemen who were curious to spend some years at a foreign court. As such, and subsequently as a third and second secretary, he gained experience for some fifteen years in the usual round of posts until in 1891 he was appointed Secretary of Legation at Tokyo, then not yet an Embassy. Three subsequent years spent as Consul-General in Siam and five as Counsellor of Embassy at Constantinople seemed to mark him as an expert in Eastern affairs. Promotion however took him to Paris as Secretary of Embassy with the rank of a Minister Plenipotentiary from 1902 to 1905. His first wholly independent post was the Legation at Lisbon, where he remained only for about a year, being selected as Ambassador to Spain in 1906. Few people, probably no one in this country, foresaw at the time that his transfer to the coveted Embassy at Vienna in 1913 was to be from a professional point of view a misfortune, and that the outbreak of war in the following year would terminate a successful diplomatic career. There was no vacant post to fill abroad, but he found plenty of work to do at home until the termination of hostilities, and during the last year of the war was despatched on a special embassy to the States of South America, which he discharged with credit to himself and advantage to his country. But his diplomatic swan-song was really the long despatch drafted after he had left Vienna and published in 'British Documents on the Origins of the War' (vol. xi), in which he summed up the events which led to the termination of his mission in 1914. When he finally retired in 1919 his distinguished services were rewarded with a baronetcy.

A man so active-minded and temperamentally young however could not remain unoccupied, and he found work to do on the Council of Foreign Bondholders and as a Director of the British Bank of South America and the São Paulo Railway. The Royal Geographical Society was fortunate also in securing as Foreign Secretary one who was an accomplished linguist and eminently a traveller. In that capacity he represented this country at the centenary celebration of the Société de Géographie in 1921 and at that of the Gesellschaft für

Erdkunde in 1928; and at the centenary of our own Society he took charge of the Foreign Delegates, whom it was his duty to present to the Duke of York.

Sir Maurice de Bunsen was typical of all that a representative of his country in foreign lands should be. Of a distinguished presence, courteous, kindly, reasonable, and ready to do justice to the susceptibilities and aspirations of the people among whom he was living, his public service was above reproach, and those who had the good fortune to have him as a chief were trained in an admirable school. He preserved his mental and physical activity throughout the eighth decade. Singularly happy in his domestic life, he seemed never to have made an enemy and was beloved by all his personal friends. R. R.

A resolution was passed by the Council on the afternoon of February 22 expressing their deep sympathy with Lady de Bunsen. At the Evening Meeting of the Society on the same day the PRESIDENT said: The death of Sir Maurice de Bunsen deprives this Society of a Fellow of forty-eight years' standing and of its Foreign Secretary. This is not the place to speak of the services which he rendered to his country, but it is the place to render to his memory the tribute due to one who had, in all his life, no thought of self. Of the many attributes which he possessed two are outstanding: his deep and intense human sympathy and his fine distinction of mind. As Foreign Secretary of the Society the regard in which he was held abroad assured to our Society the greatest attention. To many of us his death is the loss of a very great personal friend. What could be more delightful than to spend an hour in his company; to feel and enjoy that ease which he carried with him into every company and walk of life; and to listen to those attractive stories of a long life spent in most interesting circumstances; and to know that every movement which he made was actuated by simplicity of thought, a love of justice, and great courage? I shall, of course, attend, on behalf of the Society, his funeral or such memorial service as is held in his memory, and I know that when I go I shall carry with me the sympathy of every Fellow of the Royal Geographical Society.

CORRESPONDENCE

A SUBMARINE TROUGH OFF THE COAST OF CYPRUS

In the *Journal* for October 1931 Professor J. W. Gregory presented the facts relating to a submarine trough recently discovered off the coast of Cyprus and discussed its origin, especially on the hypothesis that it might be attributed to the earthquakes for which the region has a sinister reputation. In this connection Professor Gregory did me the courtesy of citing a report which I had written at the request of Sir Ronald Storrs, Governor of the Island, but which had been held as confidential, because at the time of writing it I had had no opportunity to confer with Professor Cullis or other British colleagues, whom I would have wished to consult. The reconnaissance of Cyprus was an incident in a general survey of earthquake regions, which I carried out in 1927 for the Carnegie Institution of Washington and which included Japan, the Philippines, New Zealand, and Palestine. My object in Cyprus was to ascertain if the island was under compression, as a large body of evidence had been accumulated tending to show that tectonic earthquakes which release great stores of energy occur chiefly, if not exclusively, where forces are compressive, as shown by the geological structure. The evidence observed in Cyprus was wholly confirmatory.

The island is squeezed in a north–south direction, as is demonstrated by the low-angle thrust under the Kyrenia range, which was observed independently by Dr. Cowper Reed in 1929, and by the high-angle upthrusts that bound the Troodos block. It thus presents the interesting development of horizontal and vertical displacements in one and the same crushed segment of the crust. It has been under excessive pressure during post-Miocene time and is still yielding, as the earthquakes prove.

Professor Gregory published in his note on the newly discovered trough a section which expresses my concept of the deeper structure. So far as the mechanical structure of the faulting goes, it might be produced by active pressure from the north or from the south, but the crucial question is *on which side*, north or south, *was the greater amount of energy used up* in doing the work of deformation? For that is the side of the initial effect and therefore, in the general case, of the source of pressure. I regard the work done in raising the mass of Troodos and in producing its crushed, internal structure as greater than that involved in the relatively superficial overthrusting of the Kyrenia range. If so, the active stress came from the south. This interpretation accords with the general hypothesis that orogenic pressures originate in the horizontal expansion of a layer of the crust underlying a basin, such a basin as the eastern deep of the Mediterranean (see "Metamorphic Orogeny," *Bull. Geol. Soc. America*, vol. 40, 1929).

If we attempt to fit into this picture the trough that has attracted attention we would have to consider it as a strip which has either subsided by its own weight or been pushed down to a lower level than its sides. Professor Gregory points out that its trend is parallel to the axial trends of the structure and therefore properly oriented. If it has subsided, simply under the influence of gravity, it is a tiny rift valley, a sunken keystone, and as such requires a relaxation of compression, followed by tension. Professor Gregory appears to have found in my account of Cyprus some reference to tension which led him to credit me with this idea. I would be glad to agree with him if the facts did, but unfortunately there is not a shred of evidence of relaxation of pressure or of tension in a *horizontal* direction, such as a subsidence of Troodos, for instance. *Vertical* tension is indicated by normal upthrust faulting in the Miocene cover on the flanks of Troodos, but it confirms the observation of uplift, attributable to horizontal compression.

Hence, if we attribute the trough to tectonic conditions it cannot be a *rift* valley, a dropped keystone, but would have to be a *ramp* valley, that is, a block pushed down between two thrusts ("Dead Sea Problem," *Bull. Geol. Soc. America*, vol. 39, 1928). As such it would be a consistent detail of the structure of the whole Mesorian syncline, which occupies the position of a depressed block between Troodos and the Kyrenia range. It seems out of proportion however to attribute to so small a feature as the trough an origin that is connected with large, deep-rooted structures. Local, superficial agencies seem adequate to account for it. I refer to marine abrasion or submarine scour, to which also Professor Gregory calls attention.

Deep canyons, of remarkable depth, are of common occurrence in the submerged margins of continental shelves, and this one seems to belong to that class. They are frequently discussed as evidence of a former high stand of the land and erosion by some tributary river. The so-called Hudson River trough off New York is a classic example. A comprehensive examination of their distribution and relations rather discredits the idea of sub-aerial erosion, which makes incredible demands upon Pleistocene elevation of lands, for which there is no other evidence, whereas conditions favourable for submarine scour are usually present.

In 1890 Professor James D. Dana wrote regarding the Hudson channel:

"It may be that the outflowing tide from New York Bay and from the adjoining parts of the shores of Long Island and New Jersey may have combined their forces along a diagonal line crossing the shallow Atlantic border region, and by scour only have given the existing depth as well as course to the larger part of the channel. The waters on the ebb move or settle away on more or less oblique courses toward the lowest part of the bottom for escape, and there they flow most rapidly and would erode most energetically."

The essential pre-requisite for this kind of submarine erosion is a piling up of waters sufficient to create a slight head, and it is found where tides or winds cause the waters to converge toward the upper reaches of a bay. Such is the case in the Bay of Famagusta. Tides are negligible in the Mediterranean, but Cyprus lies in the winter path of prevailing, strong east winds, on the western edge of the Asiatic area of high barometer. The great spur of the Kyrenia range is driven straight into the surface currents, which these winds produce, and diverts them toward the head of Famagusta bay. A southern promontory, Cape Greco, has a similar, though presumably slighter, effect. The shore currents converge on Famagusta and should escape about where the submarine trough actually exists. The depth of the trough, 160 fathoms, flattens out above the 200-fathom line, below which there is stagnant water, without currents, according to Carpenter, as quoted by Suess ('The Face of the Earth,' vol. ii, p. 436).

Professor Gregory refers to "marine abrasion" as a possible cause of the trough, but conditioned the idea by postulating elevation of the land and weakness in the rocks of the sea-bottom. Neither of these conditions is assumed in the hypothesis of submarine scour. The agency is a common one and it has been operating in this locality at least since the Pliocene sea withdrew from the Mesorian depression.

BAILEY WILLIS

Stanford University, California, U.S.A.

RODDONS

The communication by Major Gordon Fowler in the March issue of the *Geographical Journal* is of more than geographical interest: it is a present-day illustration of a consequence of the greater compressibility of peat than of the ordinary alluvium which fills the deserted channels of streams which once traversed the Fens, and Major Gordon Fowler confers upon geology a benefit which was little expected.

In 1918 I published in the *Transactions* of the Institute of Mining Engineers a description of a "split" coal seam, the Middleton main coal of the Yorkshire coalfield, which did not accord with the explanation offered by Bowman (*Trans. Manch. Geol. Society*, 1840–1841, vol. i, plate ii) of such partings. His suggestion —no doubt applicable to certain cases—was that a sag occurred after the deposition of the lower leaf of a seam into which, as a catch-pit, sedimentary materials would be entrapped until such time as the hollow was filled up. When the filling was completed the temporary arrest of peat growth would come to an end and formation of peat by growth and decay of plants would be resumed. The essential feature of Bowman's explanation was the local subsidence; and a seam so affected would exhibit a concave sag of its bottom member, while the plane of the upper element would not be disturbed.

In the paper referred to I described the course of what was evidently a river of Coal Measure age affecting the deposition of the seam in a succession of collieries ranging in a south–north direction, in which the *lower* leaf of the seam preserved its general plane though with interruptions where the seam was still

unworked, while the upper element, or elements, rose in an arch some 30 feet in height, the interval being occupied by sedimentary materials laid down by the river. In other words, the sedimentary lens was reversed.

The difference between Bowman's explanation and mine was that his applied to seams affected by a "sag" while mine demanded no such change of level but relied only upon such floods, temporary or not, each case to be judged by the details of the margins. My views have been set forth at greater length in 'The Geology of Yorkshire,' by H. E. Wroot and myself.

I have now seen many of Major Fowler's examples under his guidance, and I can testify that they reproduce in a remarkable way the conditions I have supposed to have existed in a swamp in Coal Measure times.

I have to thank Professor O. T. Jones for having brought to my notice Major Fowler's remarkable observations.

PERCY F. KENDALL

MEETINGS: SESSION 1931–1932

Eighth Evening Meeting, 22 February 1932. The President in the Chair

Elections: F. Irvine Burnham; Eric Douglas Sibun Lane; Mrs. T. H. McKittrick; H. L. Monkcom, B.SC.; James Leonard Palmer; Bernard E. Penrose; R. H. Porters; H. Robertson, B.A.; The Rev. Thomas Sefton.

Paper: A Fourth Journey in the Tien Shan. By Lieut.-Col. Reginald Schomberg

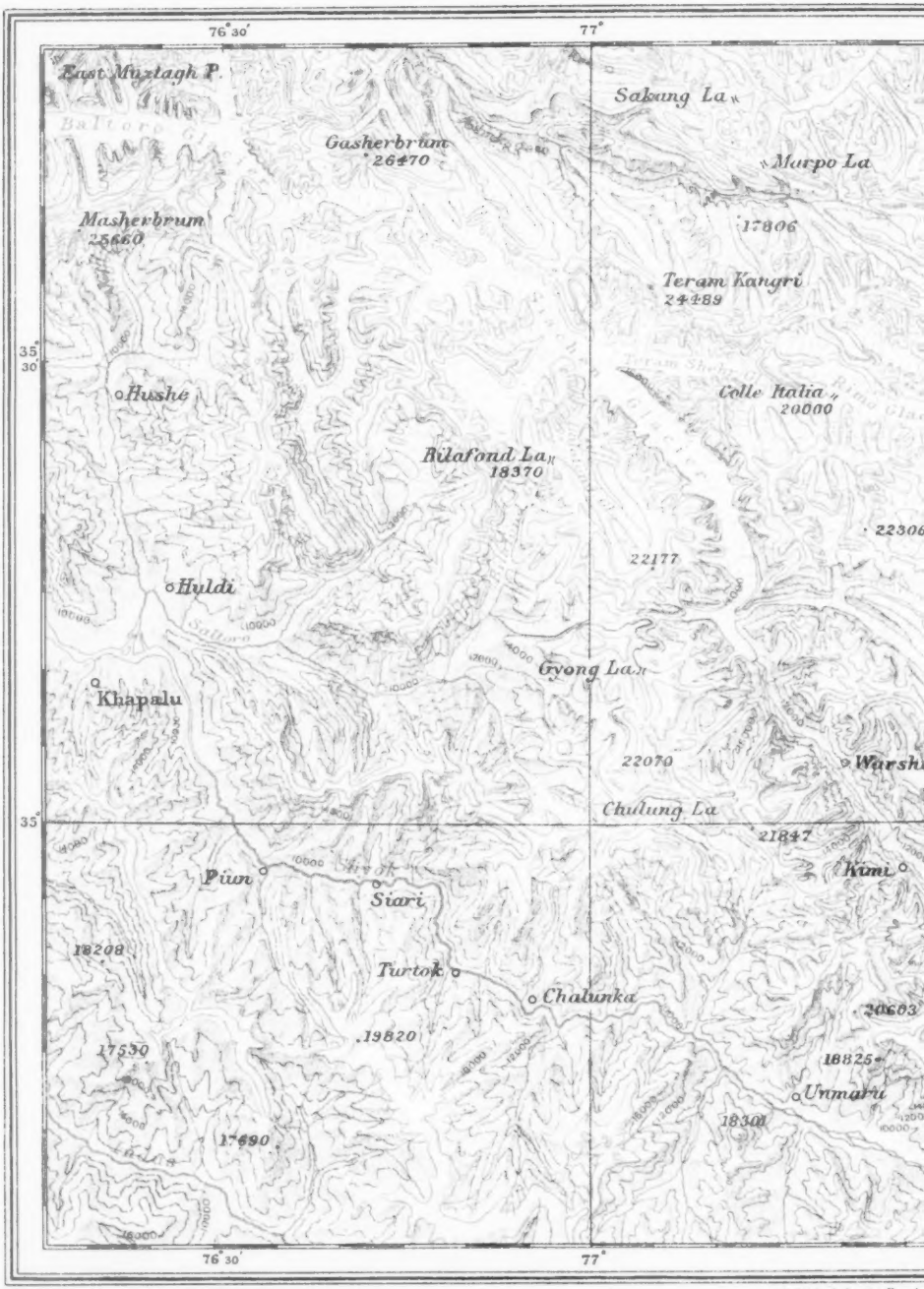
Ninth Evening Meeting, 7 March 1932. The President in the Chair

Elections: Capt. Frederic Longridge Barnett; John Bentley; Sydney Bolsom; John Francis Boulton-Lea; Dixon Byrde Brown; Reginald Boyd Cooper; The Rev. George Daulby; Leslie de Saram; K. C. Dhir, B.A.; Mrs. Sylvia Dickenson; The Rev. George A. Dickson, D.D.; Charles Donald Ellicott; Harold Edmund Franck; Miss Alison Hilda Giles; Miss Dorothy Christian Hare, C.B.E., M.D.; Herbert Hawley; Lady Lechmere; Mrs. Arnold Moritz; William Robert Oaten; Andrew C. O'Dell, B.SC.; William Vernon Peek, M.A.; Mrs. Ellen Maud de Clare Richards; Alec Riley; Mrs. Enid Seymour-Eyles; Henry Thomas.

Paper: The B. A. N. Z. Antarctic Research Expedition 1929–31. By Sir Douglas Mawson; read in his absence by Professor Debenham

Fifth Afternoon Meeting, 14 March 1932. The President in the Chair

Paper: Alleged Changes in the Climate of Southern Turkistan. By Lieut.-Col. Reginald Schomberg



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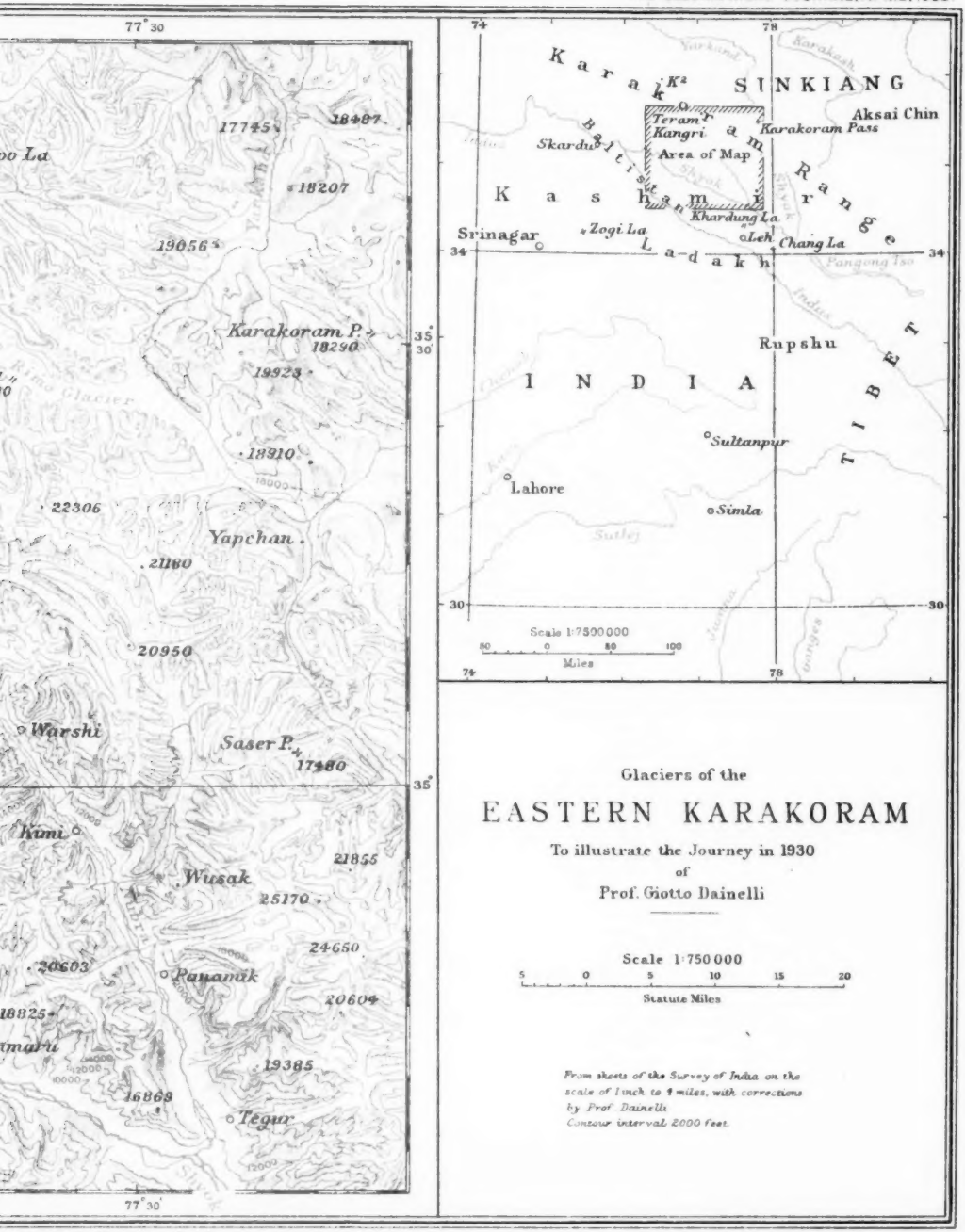

Glaciers of the

EASTERN KARAKORAM

To illustrate the Journey in 1930
of
Prof. Giotto Dainelli

Scale 1:750000

5 0 5 10 15 20

Statute Miles

From sheets of the Survey of India on the scale of 1 inch to 4 miles, with corrections by Prof. Dainelli.
Contour interval 2000 feet.

EASTERN KARAKORAM
Dainelli

Map
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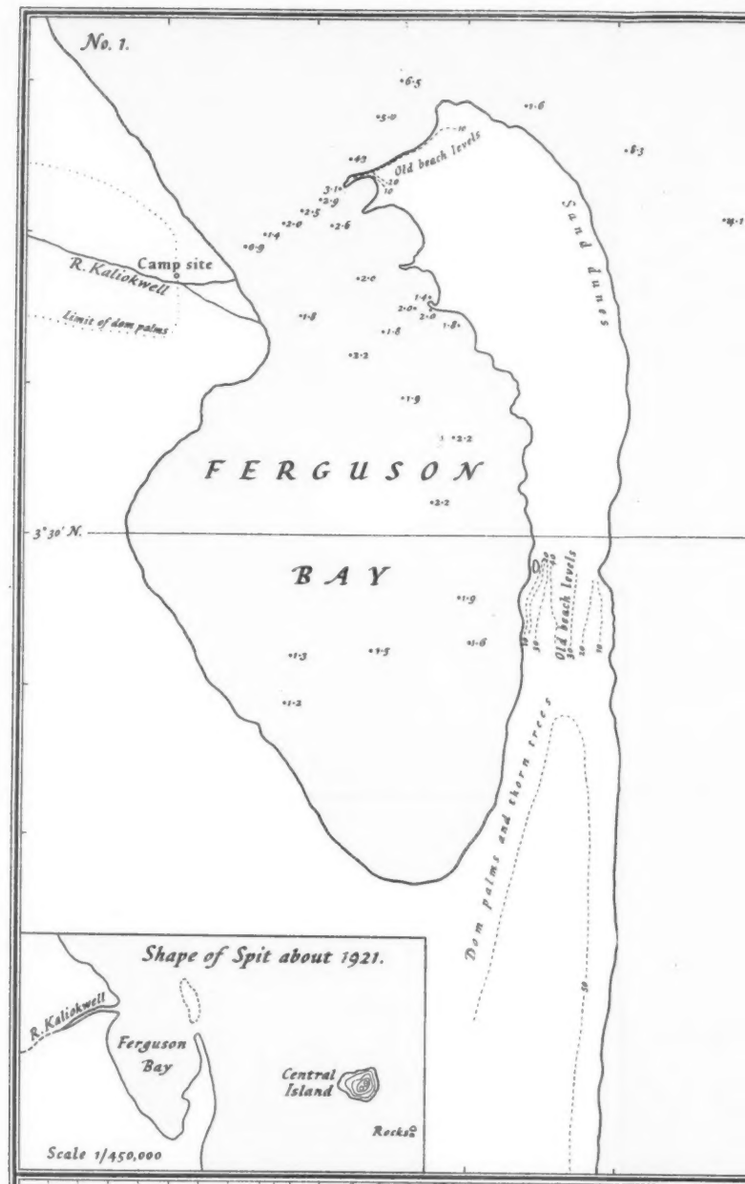
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Old beach levels
Sand dunes
Camp site
R. Kaliokwell
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BAY
3° 30′ N.
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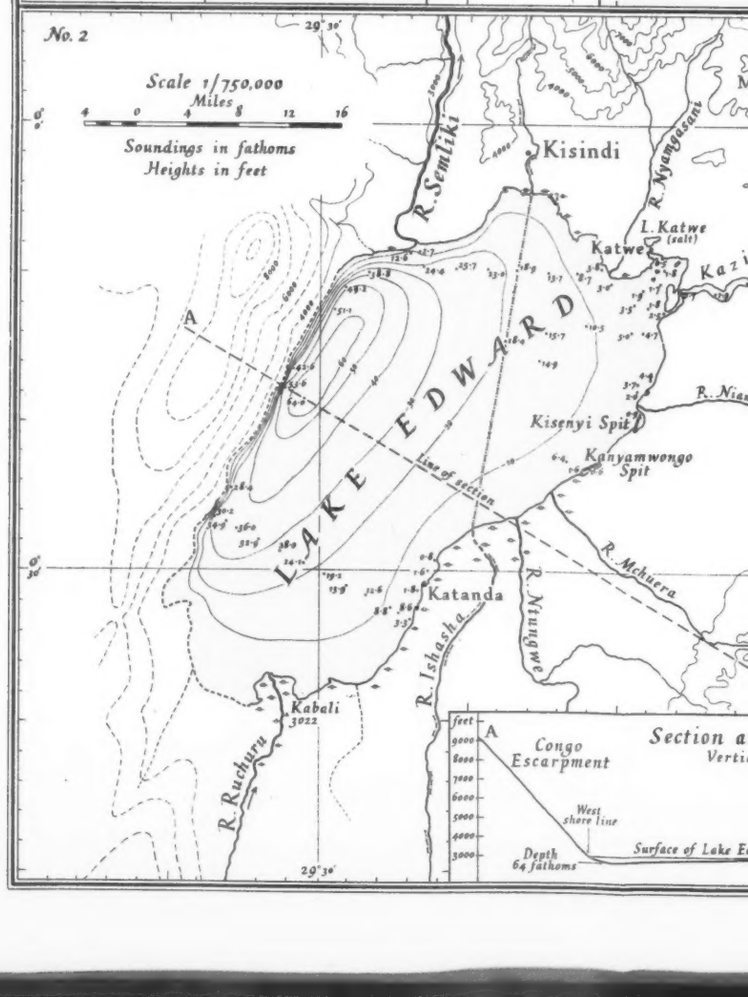
Shape of Spit about 1921.
R. Kaliokwell
Ferguson Bay
Central Island
Rocks
Scale 1/450,000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R. Nyungwe
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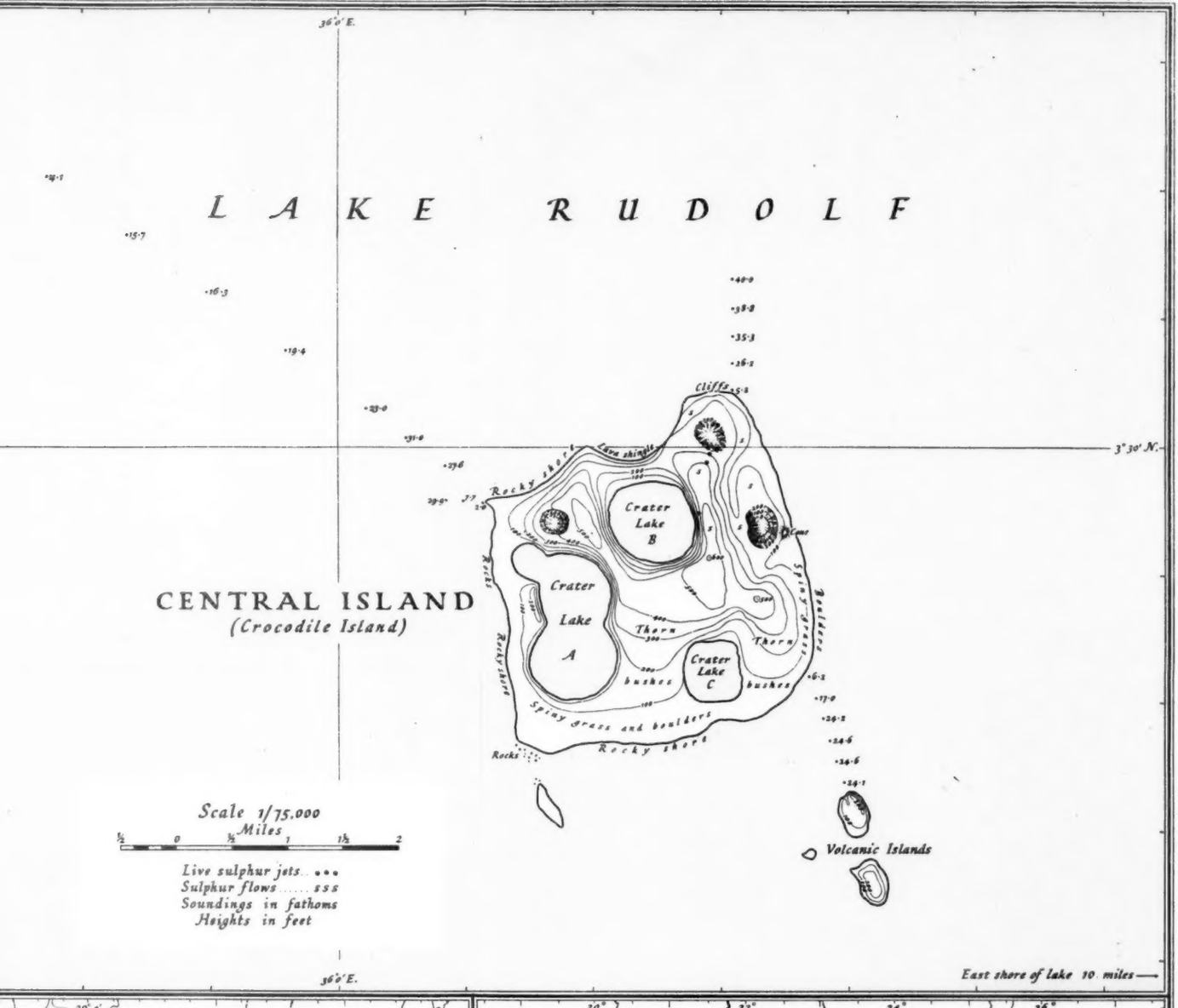
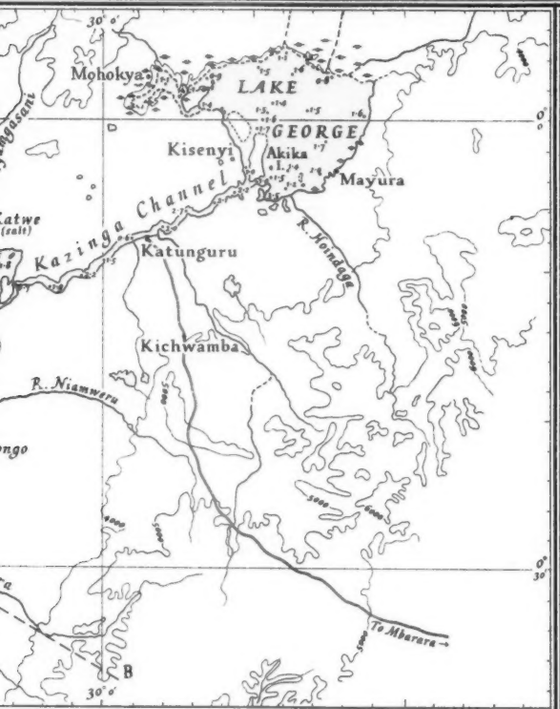
Maps to illustrate Dr. E. B. Worthington's paper on

THE LAKES OF KENYA AND UGANDA

investigated by the Cambridge Expedition, 1930-31





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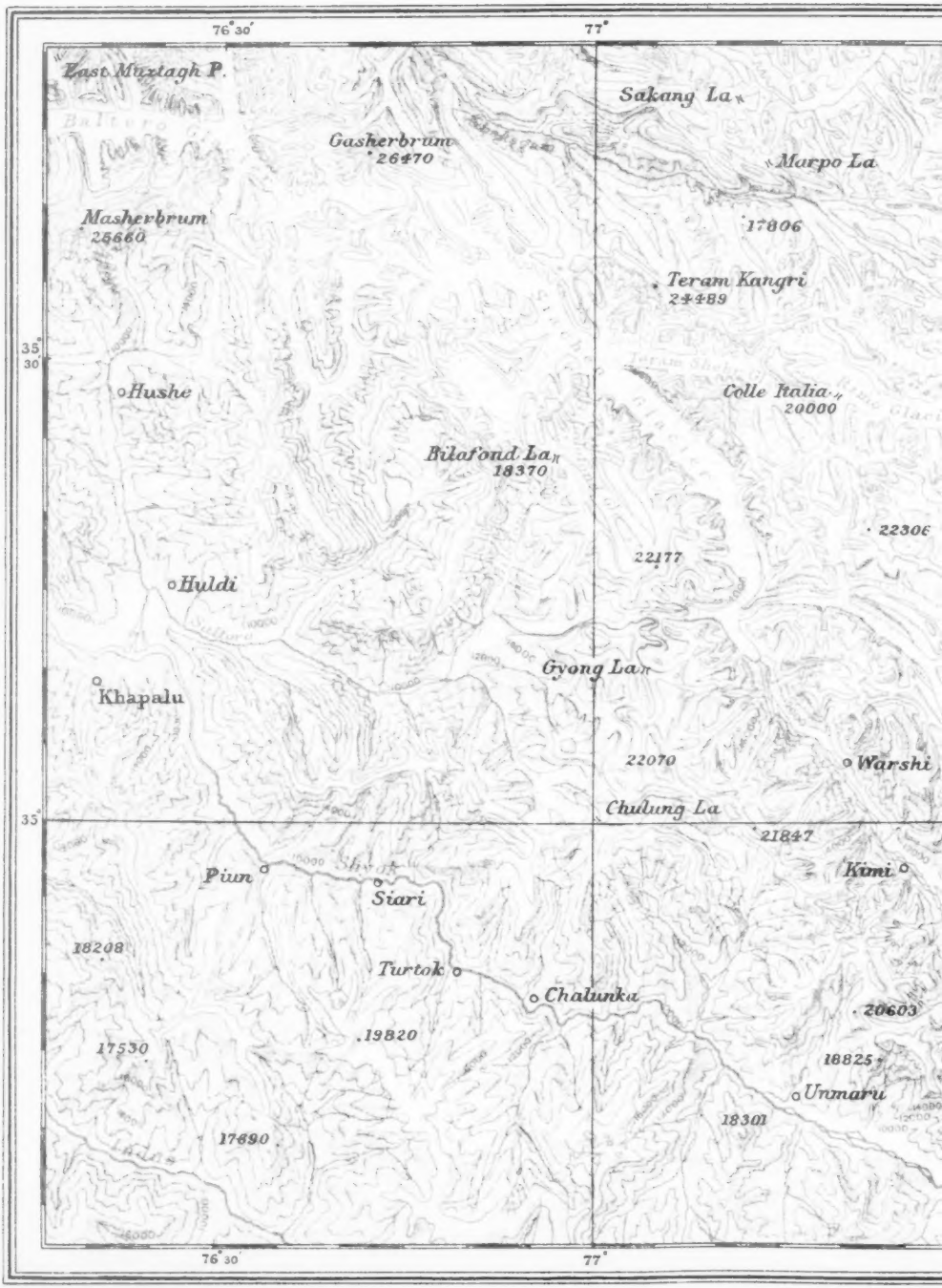
EAST AFRICAN LAKES
Worthington



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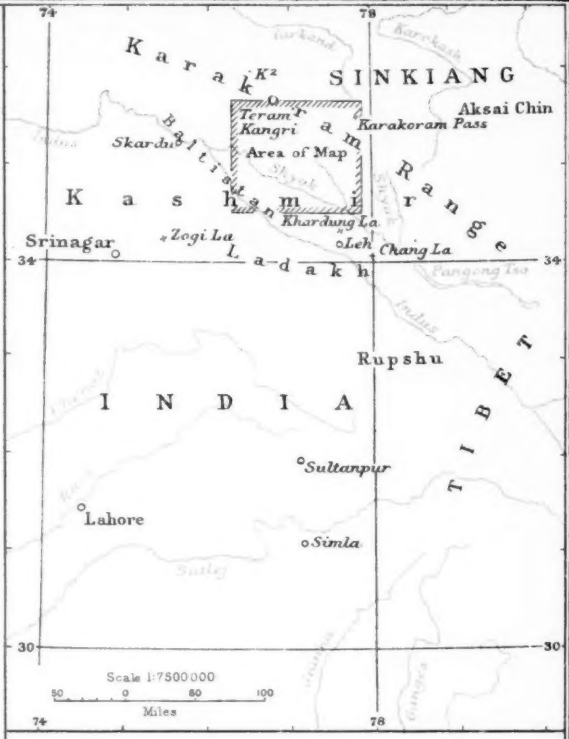

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